THURSDAY DECEMBER 12, 1895.

THE HISTORY OF MATHEMATICS.

Geschichte der Mathematik im Alterthum und Mittelalter. Vorlesungen von H. G. Zeuthen. Pp. viii. + 344. (Kopenhagen : Höst, 1896.)

A Primer of the History of Mathematics. By W. W. Rouse Ball. Pp. iv. + 146. (London : Macmillan and Co., 1895.)

THE first of these books is a translation, with some alterations and additions by the author, of a work originally published in Danish in 1893. Its aim is to supply students and teachers of mathematics with trustworthy information about such parts of the history of the subject as are really important for them to know ; and, in particular, account has been taken of the fact that candidates for the Danish teachers' certificate are expected to show an acquaintance with the text of Euclid's Elements, as well as a general knowledge of the history of mathematical science. This plan has been effectively and judiciously carried out, and the result is a work of permanent value and interest, admirably suited for the class of readers for whom it is designed.

Dr. Zeuthen has very wisely adopted the course of tracing the lines of formal development along which the science of mathematics has progressed. This does not exclude the special consideration of the works of mathematicians of first-rate importance, while at the same time it brings clearly before us the different springs and rivulets, so to speak, which have converged into the broad and deep streams of modern geometry and analysis. Thus we are shown how the speculative and logical intellect of the Greeks built up a system, mainly geometrical, which at last seemed to become inert from the very perfection of form which it had attained ; how the decimal notation of arithmetic and the elements of algebra, slowly evolved by the Indians, eventually made their way into Europe ; and, finally, how mathematical science, preserved from extinction by the Arabs amid the ignorance and bigotry of the dark ages, woke up to new life in the thirteenth century, and grew slowly but steadily thenceforth, until the analytical method of Descartes and the invention of the infinitesimal calculus marked the beginning of a new era, the splendour of which has perhaps unduly obscured the achievements of all the ages which went before. We are all too apt to forget what we owe to our forgotten, unhonoured ancestors ; and it is well that we should be now and then reminded that the exact science to which we are indebted for mos our "triumphs of civilisation," and which is ruly the finest product of the human mind, may be traced back to the dawn of history and the rude efforts of primitive man in the arts of counting and measuring.

But to return to Dr. Zeuthen's book. After a few introductory pages, devoted to *Vorgeschichte* and the Egyptians and Babylonians, we reach the longest and most interesting section of the work—that which treats of Greek mathematics. Here we have a clear, well-proportioned outline of the progress made from Thales to Diophantus, and of the scope and methods of Greek geometry and arithmetic, together with a sufficient analysis of the works of Archimedes, Apollonius, Diophantus, and more particularly Euclid. An interesting account is also given of the researches connected with the three famous problems of antiquity—namely, the trisection of an angle, the duplication of a cube, and the quadrature of a circle. (Archytas's construction for the second of these problems (pp. 84–5) is not very easy to follow : it would be an improvement to give a figure showing the circle traced out by the point Y.)

The amount of space given to the discussion of Euclid's Elements is justified by the importance of the subject. Dr. Zeuthen's criticisms of the definitions and postulates, and of Euclid's geometrical presuppositions, are very instructive ; and his analysis of the contents of books v., vii.–xiii., ought to be of great service to students of the original text. There is only one point about which we would venture, with all respect, to differ from the author's conclusions. Dr. Zeuthen appears to regard the arithmetical books, and in particular book vii., as containing a theory of commensurable quantities ; so that, for instance, the theory of proportion in book vii. is merely the substance of book v. adapted to commensurable ratios, and was composed because the general theory of proportion was still unfamiliar. This is not very plausible, *prima facie ;* and it is, we think, disproved by the facts of the case.

The second definition of book vii. undoubtedly means "A number is an assemblage (πλῆθος, not μέγεθος) composed of units" ; and if the word μονάς has the same meaning in the first definition that it has in the second (and this is almost necessarily the case), the true sense of the first definition will be "Any object whatever is a unit [or is regarded as a unit] when it is spoken of as *one.*" If this be so, it is quite clear that we have to deal with a purely arithmetical theory ; and there is nothing whatever in the form or matter of the seventh book inconsistent with this conclusion. It may be added that the definition of proportion in the seventh book is essentially distinct from that in the fifth ; and that in some MSS., at any rate (*cf.* Gow's "History of Greek Mathematics," p. 74, note 3), numbers are represented by dots, and not by lines.

On the other hand, the tenth book does deal with quantities, and begins with a definition of commensurable quantities ; a definition which, according to Dr. Zeuthen's theory, ought to have been given long before. It is quite possible that Euclid perceived the analogy between commensurable numbers and commensurable magnitudes ; whether he realised the ratio of two commensurable quantities as a fraction in precisely the same wa as we do is doubtful : it is almos certain that he ha no conception of surds as *numerical* quantities.

The Indians did not scruple to introduce irrational as well as negative numbers ; by so doing, and by their invention of the decimal system of notation, they immensely extended the range of analysis, probably without knowing what they did. Except in the region of diophantine analysis, their particular discoveries are comparatively unimportant. However, Dr. Zeuthen does them full justice for all their researches ; and we are glad, also, to see that he has a kindly word for the Arabs, who not only guarded the treasures of learning, but added something of their own to the store. Thus

we learn that Alkhojandi, about 1000 A.D., discovered that the equation $x^3 + y^3 = z^3$ does not admit of rational solutions.

A brief outline of the period 1200–1500 brings this excellent book to its conclusion. That it is the outcome of independent and careful research is evident; and the reader's appreciation of this fact is rather enhanced than otherwise by Dr. Zeuthen's graceful acknowledgment of his obligations to his predecessors in the same field, more particularly to Cantor and Tannery.

Mr. Ball's "Primer" is a work of a very different scope. Its object is "to give a popular account of the history of mathematics, including therein some notice of the lives and surroundings of those to whom its development is mainly due, as well as of their discoveries." It is expressly said that it is not intended for those to whom the subject is familiar. The plan adopted is to give a series of brief biographies in chronological order, interspersed with occasional paragraphs on particular periods. The necessary element of "human interest" is supplied by a number of anecdotes. Many of these are pertinent enough; others are certainly superfluous. Why should half a page be devoted to the unhappy matrimonial experiences of Kepler? or, again, what is the value of the information that Descartes in Paris was "modestly clad in green taffety?"

Still, the book is entertaining, and, although very sketchy, fulfils its purpose well enough until we come to the last section, which treats of recent mathematics. Here the difficulties of the subject, and the narrow limits of his plan, have been too much for the author. That this should be the case is not altogether surprising; but some of the faults of omission and commission are too serious to be passed over.

Thus in the paragraph on Cauchy, no mention is made of his work on the theory of numbers, or of his great memoir on waves. The statement that "the rule for finding the principal values of integrals was enunciated by him, and the calculus of residues was his invention," is much as if one should say "Newton discovered the binomial theorem and wrote the 'Principia.'" Worst of all, the account concludes with the remark: "In many of his memoirs the feverish haste with which they were thrown off is too visible, and several are marred by obscurity, repetition of old results, and blunders." Such criticism of a great genius is in questionable taste, and is apt to recoil on the person who makes it. It seems to us rather obscure to say (p. 132) that "in this theory the theta-functions are independent of the form of their space-boundaries"; and that Eisenstein "considered the theorems relating to the possibility of representing a number as a sum of squares, and showed that the general theorem was limited to eight squares." Will not the general reader infer from this that no number is the sum of more than eight squares?

Then as to inadvertent errors (it would be unkind to call them blunders): (1) it is not true that "the only regular polygons which can be constructed by elementary geometry are those of which the number of sides is $2^m(2^n + 1)$, where m and n are integers and $2^n + 1$ is a prime"; even Euclid could construct a regular quindecagon; (2) the theory of ternary quadratic forms is not due to Eisenstein; (3) Eisenstein did not give a rule for distinguishing whether a given series represents an algebraical or a transcendental function (see Heine's "Kugelfunctionen," 2nd edition, i. p. 50); (4) Abel did not prove that it is impossible to solve a quintic equation by means of radicals, but the quite different proposition that a root of the *general* quintic cannot be expressed in terms of its coefficients by means of radicals.

Finally, the omission of all notice of Galois is entirely inexplicable. The pathetic story of his death appeals to universal sympathy, and might even draw a tear from the hardened general reader; while the influence of his work upon recent analysis is, perhaps, second only to that of Riemann.

Fault-finding is not pleasant, and is apt to bulk too largely in a review. Mr. Ball's readers may not be impressed by the fact that Cayley "introduced the so-called 'absolute,'" and they may be inclined to think that "homaloidal hyper-space" is a somewhat technical expression; but they will find plenty of amusement in the "Primer," and a good deal of instructive reading; while, for reasons which are different, but each sufficient, the occasional *lapsus calami* will do neither the instructed nor the uninstructed reader any harm. G. B. M.

THE SPIDERS OF BURMA.

Descriptive Catalogue of the Spiders of Burma, based upon the Collection made by Eugene W. Oates, and preserved in the British Museum. By Dr. T. Thorell (London: printed by order of the Trustees, 1895.)

DURING his residence in British Burma, in the capacity of civil engineer, Mr. E. W. Oates availed himself of the rare opportunities of travelling, afforded by his official duties, to investigate certain portions of the fauna of the country, choosing as objects of special study such diverse groups as Scorpions, Whip-Scorpions, and Spiders; Centipedes and Millipedes; and Birds. It was, we believe, primarily his intention to work out all his collections himself upon his return to England on furlough. In fact, while still in the East he published, in the *Journal of the Asiatic Society of Bengal*, descriptions of his new species of Whip-Scorpions (*Thelyphonus*), and shortly after his arrival, his paper upon the Indian and Burmese species of Scorpions of the genus *Isometrus* appeared in the *Journal of the Bombay Natural History Society*. But further than this, his studies in the invertebrate portion of his material did not go; and realising the impossibility of grappling in the space of time at his disposal with the vast number of species of spiders and myriapods that he had procured, he generously presented these in their entirety to the Trustees of the British Museum, and devoted his energies to the study of the Birds of British India and Burma, of which he had already acquired considerable knowledge. In the course of the next few years, the Centipedes and Millipedes were determined and reported upon in a series of memoirs that appeared in the *Annali del Museo Civico di Genova*. The spiders, however, were, at Mr. Oates's request, submitted for examination to Dr. T. Thorell, who had already made himself an authority upon Burmese Arachnida, in connection with the study of the material of this group amassed under the auspices of the Marchese G. Doria by that practised

collector, Sig. L. Fea. But although the Italians, in the persons of Sigg. Fea and Comotto, had had the first bite at the Burmese Arachnid fauna, the careful sorting and examination of Mr. Oates's collection soon showed that this gentleman had more than doubled the number of known Burmese spiders. For whereas only 175 species had been previously recorded, the total number now amounts to no less than 381. Mr. Oates's collection thus contains 206 species that are new to Burma, and of these 153 appear to be new also to science. It comprises, moreover, either the males or females of many species of which only one sex had been hitherto described.

The secret of Mr. Oates's success as a collector of spiders is to be attributed partly, of course, to his paying special attention to them, but largely to his ingenious mode of attracting them. He tells us that—

"The greater part of the collection was made at Tharrawaddy [a station about seventy miles north of Rangoon], where I had a large garden, and a portion of it was specially prepared for the attraction of spiders, which came to it in large numbers. I put in plants of those species which my experience told me were specially affected by spiders, and by this means I was able to observe very many species in a small compass. By carefully watching the females for some weeks, I generally contrived to secure the males in such a manner as to render their identification with their respective females certain. In addition to the garden, there were large forests not far from my house. I collected at all seasons of the year, but I found the rains, from May to October, most productive. I was greatly assisted by my wife, who soon overcame her natural repugnance to spiders, and handled them freely."

With such exceptional opportunities of observation at his command, it is a matter for regret that Mr. Oates made so few notes upon the bionomics of the species he collected. For it is no exaggeration to say that if records had been kept in the case of each species of its habitat, and method of courtship and of the structure of its cocoon and snare, the value and interest of the collection would have been greatly enhanced. In the case, however, of *Herennia multipuncta*, an Epeiroid allied to *Nephila* and *Argiope*, and widely distributed in the Oriental region, Mr. Oates made the following observation:

"Makes a web about three feet long on a smooth tree-trunk, width one-third or one-fourth of girth of tree. All the lines are vertical or horizontal, forming a perfect rope-ladder. The web follows the convexity of the trunk, and is everywhere about half-inch from it. Verticals about one inch apart, horizontals about quarter of an inch apart."

With justice does Thorell term this: "annotatiunculam magni momenti," and add "rete formæ adhuc plane ignotæ igitur facit, *Herennia multipuncta*"! Curiously enough, however, M. Simon asserts that this same species, as observed by him in Ceylon, makes a snare, as indeed one would have supposed to be the case, of the ordinary orbicular type. We are consequently at a loss to know quite what value is to be attached to Mr. Oates's statement.

Turning to the spiders themselves, perhaps the only one amongst the new genera and species that calls for special mention is the remarkable new form *Prolochus longiceps*, which although presenting many points of similarity to the familiar epeiroid, *Meta segmentata*, differs from all the orb-spinners that have been hitherto described, in having only six large eyes and the cephalic region of the carapace very high and long. In this last respect it somewhat resembles the spider named *Archæa*, which was described by Koch and Berendt from the Oligocene amber beds of the Baltic. Thorell consequently refers it, although provisionally, to the Archæidæ (written by him Archæoidæ), and classes the family with the Retitelariæ, although for what reason does not appear. Probably the best way of disposing of the difficulty would have been the establishment of a new family for the reception of this anomalous spider.

So far as the rest of the genera and species are concerned, there appears to be nothing particularly remarkable in the collection, excepting only the new genus of Attidæ named *Ligdus*, which in its flattened form and the position of its enlarged first pair of legs presents a strongish superficial resemblance to one of the False-Scorpions (*Pseudoscorpiones*).

Most persons who glance through this book will probably be surprised and disappointed to find that the 400 pages of letterpress are relieved by no illustrations; but those who are familiar with the rest of Dr. Thorell's works, will know what they have to expect on this head. The lack of figures, however, is made good, as far indeed as is possible, by the fulness of the specific descriptions, which often run to more than two pages of print. Some, perhaps, may be disposed to think these descriptions are unnecessarily long; but on such a point, Dr. Thorell's opinion is probably of greater value than that of any other person: and it is only fair to him to mention that, in addition to the description, a briefer diagnosis of each species is subjoined, so that the attempt to identify a species does not necessarily entail a large amount of fruitless reading. We greatly regret, however, the author's stern adherence to the practice of not compiling synopses of his species. For there is nothing like a carefully compiled synoptical table for bringing home to an author and his readers the essential characteristics of the species being dealt with.

In the introduction Dr. Thorell takes the opportunity of explaining his opinions upon some of the many vexed questions connected with zoological nomenclature. But although we find it impossible to agree with all that he holds, the views of such an accomplished linguist are worthy of the greatest attention, especially where questions of philology are concerned; and we earnestly commend them to the notice of those who in the construction and adoption of zoological names wantonly violate every canon of etymology, until "it seems as if neither common sense nor the dignity of science can claim any rights against the whims, carelessness, or ignorance of certain authors." Speaking, for instance, of the adoption without alteration of ungrammatically formed specific names, Dr. Thorell says:

"It is an essential rule in the Linnæan system that the scientific names of plants and animals shall be in *Latin*, at least as to their form. Now as a great number of specific names consist of the genitive of personal proper names, that genitive should, when possible, be formed in analogy with the genitive of Latin names or other words of a similar form. The genitive, for instance, of Caligula,

Livius, and Catullus being *Caligulæ*, *Livii*, and *Catulli*, I cannot accept such specific names as *Doriai*, *Retziusi*, *Catulloi*, but consider that they should be corrected to *Doriæ*, *Retzii*, *Catulli*."

With regard to genera, Dr. Thorell considers that such terms as *Scorpio* and *Aranea*, cannot be used in a generic sense, because in the plural form they are applied respectively to the orders of Scorpions and Spiders. This view, however, is, we venture to think, untenable. For the terms were used by Linnæus generically before they were used ordinally; therefore, if it be considered necessary to change either the generic or the ordinal name, it is surely the latter that should be abolished. Moreover, in the interests of nomenclature it is more important that the generic name should be stable than the other. And curiously enough, Dr. Thorell, with apparent inconsistency, seems to take this view of the case when there is any clashing between the name of a family and of one of its genera. For he always, and we believe correctly, forms he family-names with the terminat:on—oidæ, such as Lycosoidæ instead of the more usually accepted Lycosidæ. But he affirms that if there be a genus termed *Lycosoides* contained in the family Lycosoidæ, the latter name must be altered, and a new one constructed from some other genus, *e.g. Trochosoidæ*, be adopted. The practical application of this view has led him to abandon such ong-established family-names as Epeiroidæ, Thomisoidæ, Attoidæ ; but if it were to be consistently and universally adopted, it is clear that all the family-names now in vogue, and every successive substitute, might have to be changed and again changed *ad infinitum*.

One other point deserving of notice is Dr. Thorell's opinion that the priority of *species*-names should be reckoned from 1751, when Linnæus, in his "Philosophia Botanica," proposed and gave rules for his binomial nomenclature. Most zoologists now refer back to 1758, the date of the publication of the tenth edition of the "Systema." But Linnæus's disciple Clerck published in 1757 his classical work "Aranei Suecci," in which he describes and gives good coloured figures of about sixty species of Swedish spiders, with binomial names according to Linnæus's system, and no arachnologist can admit that these names ought to be rejected simply because they were published *before* the tenth or twelfth edition of the "Systema." Such questions as these, however, we may perhaps leave with safety and confidence in the hands of the two recently appointed bibliographical committees, from which so much is expected. R. I. P.

COLOUR VISION.

Colour Vision: being the Tyndall Lectures delivered in 1894 at the Royal Institution. By W. de W. Abney, C.B., D.C.L., F.R.S. (late R.E.) Pp. ix. + 231, 8vo. (London: Sampson Low, Marston, and Co., 1895.)

CAPTAIN ABNEY has long been known as the authority upon the scientific measurement of colour, and his researches have naturally involved a continual attention to the problems of colour-vision. This, too, he has made the subject of measurement in numerous ways, and in observations extending over many years. The results of his work in the domain of colour-vision were systematically expounded by him in the "Tyndall Lectures" of 1894, and have now been recast in their present form. The volume, which is sumptuously printed in double-leaded type, is illustrated not only by numerous cuts and process-blocks, but by an excellent chromolithographic spectrum chart of the typical cases of colour-vision. It is worthy of the reputation of the President of the Physical Society, and constitutes a distinct addition to the literature of physiological optics.

The work, as published, is now arranged in chapters without reference to the original disposition of the subject-matter when delivered in the form of lectures; and a very large portion of the book is devoted to the various cases of colour-blindness, both congenital and acquired, including the species of amblyopia due to excessive use of tobacco. In the opening chapter, which deals with the anatomy and physiology of the eye, the fascinating theory of the "visual purple" is mentioned, only to be at once dismissed as incompatible with the fact that that part of the retina which is most sensitive both to light and colour, the forea centralis, is destitute of the structures which alone contain the substance which possesses the purple reaction. The second chapter deals with the wave-lengths that correspond to the several colours of the spectrum, and with the apparatus devised by the author for producing any desired mixtures of spectrum tints for the purpose of colour-matching. The physical proofs that green is a primary colour because it cannot be made up by mixing any two other colours, and that yellow is not a primary because a yellow can be made by a mixture of two others, are given very clearly. On p. 24 the author remarks that "we are all familiar with the fact that there are three primary colours," whereas the fact is not that the colours are primary, but that the sensations are primary; and he assumes, without any proof save that of indirect inference, that these primary sensations are three in number. Indeed, in another passage the admission seems to be made that the sensations which are primary are four in number.

Quoting from Prof. Michael Foster's epitome of Hering's theory of colour-vision, the author gives the following statement.

"The sensations caused by different kinds of light, or by the absence of light, which thus appear to us quite distinct, and which we may speak of as 'native' or 'fundamental' sensations, are white, black, red, yellow, green, blue. Each of these seems to us to have nothing in common with any of the others, whereas in all other colours we can recognise a mixture of two or more of these. . . . Hering's theory attempts to reconcile, in some such way as follows, the various facts of colour vision with the supposition that we possess these six fundamental sensations. The six sensations readily fall into three pairs, the members of each pair having analogous relations to the other. In each pair the one colour is complementary to the other, white to black, red to green, and yellow to blue."

Commenting on this theory as so stated, Captain Abney says that it should be described as "tetra chromic" (should it not be chromatic?) rather than "tri-chromic," for as far as "colour" is concerned, the black-white sensation must be excluded But, surely

there is much more to criticise in so crude a presentation of the case. Is not brown just as truly a "native" or "fundamental" sensation as green or blue? Without an education it would be impossible to pronounce it to be a mixture of any other two of the "native" sensations. The writer would go further, and include amongst native sensations that of purple, the pure full purple so rarely occurring in nature. To him, indeed, violet suggests a mixture of blue and purple, while crimson suggests a mixture of the sensations of purple and red. Further, it is not strictly true of the six supposed native sensations connoted by the six names given above, that they are in each pair complementary to each other. The true complementary to yellow is violet, not blue; the true complementary to blue is orange, not yellow. The true complementary to red is not green, but blue-green or peacock; and the true complementary to green (full green) is not red, but a crimson tending toward purple.

In other parts of the work, Hering's theory is compared with Young's theory; and a really decisive point in favour of the latter is made on p. 136, where it is shown, from the experiments made on the gradual extinction of luminosity down to the tints that persist last when all others have become invisible, that the finality of disappearance in the case of persons of monochromatic vision is inexplicable on Hering's physiological assumptions.

Many other points in the work show acute observation. The remark that no colour-match can be accepted unless we know the portion of the retina used in the operation is an instance, for the match will be different if the portion used is the macula lutea instead of a larger area of retinal surface; while, again, the colour-vision at 10° obliquity differs even in the normal eye from that of the forea centralis. The instructions how to pick out from the spectrum tints those which excite sensations that are primary, on p. 93, though not too clearly expressed, are readily understood; and of great value to future workers. The experiment of producing the neutral or a-chromatic sensation of light by means of a glow-lamp under a shade of blotting-paper, is both novel and neat.

Unfortunately the author occasionally uses words and phrases in a special or technical sense of his own devising, and which he does not define. It is left to the reader to discover, if he can, what the meaning is. For example, on p. 112, the words "the extinction" are used not to mean the disappearance of the light, but to mean, apparently, the percentage degree to which the light has to be reduced in order to be practically imperceptible. Unless one finds out by some sort of intuition that the word is being used in this unusual sense, one is puzzled to read three pages further on that "if we multiply the extinction by the luminosity, we shall get what we want.' Indeed, the word "luminosity," used so often throughout the work, needs to be better defined; and it ought to be used, when defined, only in one sense. There are several passages in which the word occurs, where it is not evident whether the term "luminosity" refers to the number of candles per unit area (the sense in which one would speak of the intrinsic or specific luminosity of the crater of the electric arc, or of the flame of a lamp), or whether it refers to the illumination of a surface in terms of the illumination due to a standard light at a standard distance, or, lastly, whether it refers to the apparent luminosity as viewed by a person of possibly abnorma vision. Yet at the bottom of p. 115 we are told that the author has taken "the luminosity of the yellow light near D [in a particular experiment] as one amyl acetate lamp." Taken literally and grammatically, luminosity here means simply "one lamp" of a kind that is known to be equal to about 0·87 of a standard candle. The plaintive remark on p. 181, that the word "brightness" is misleading to some people who are uneducated, is a curious commentary on the use of a word that will mislead some who are not uneducated. In a certain "criterion by the luminosity method" (p. 182), red is placed beside white, and the subject is asked to say which he considers the *darker*. This is to avoid asking him (lest it should be misleading) which he considers the brighter. Does the word luminosity as here used mean anything more than brightness? Again, on p. 110 we read: "The spectrum was of such a brilliance that the intensity of the square patch . . . of the orange light (D) was exactly that of an amyl-acetate lamp, placed at one-foot distance from the receiving screen. Knowing this, the actual luminosity of all other rays of the spectrum can be derived from the curve of luminosity." In this passage, has not the word "intensity" precisely the same meaning as "luminosity"? And does not the word "brilliance" again mean the same thing? Would not the passage be exactly as clear if the word "brightness" had been used instead of the three different words in the places where they occur?

The most valuable part of the work is that which relates to colour-blindness, where, for the first time, there are given charts showing the degree of *apparent* luminosity (the qualifying adjective is the reviewer's) in different parts of the spectrum to persons having one or other variety of colour-blindness. One case, mentioned on p. 85, is of exceptional interest. This is the case of a person who, though he sees each of the three fundamental colours quite correctly, red as red, green as green, violet as violet, is relatively less sensitive to green than other persons of normal vision. "He is defective in the green sensation, although it is present to a large extent." Here is a person who certainly would be quite capable of doing duty as an engine-driver or as a seaman, perfectly able to distinguish green lights from red, but who yet would be condemned, if tested by the much over-rated method of Holmgren, as being colour-blind. Indeed, the least satisfactory part of Captain Abney's book is that wherein, in the face of this very case in which Holmgren's wool tests would unjustly condemn a man, he describes and praises the Holmgren method of testing colour-vision. There is not one word of warning as to its uselessness in such cases, or as to its misemployment by practitioners devoid of any training in the optical laboratory. Captain Abney says that he "is glad to say" that the Holmgren system has been adopted by the Board of Trade and by most of the railway companies in the United Kingdom. The pity is, that no one explains to those who have to use it how easily the coloured wool test may be (and actually is) misused, and how in certain cases, like that cited, its indications may inflict a serious injustice. S. P. T.

SELBORNE ILLUSTRATED.

Natural History of Selborne, and Observations on Nature. By Gilbert White. With the Text and New Letters of the Buckland Edition. Introduction by John Burroughs. Illustrations by Clifton Johnson. Pp. xxiii., vi., 208, 231. (London and New York: Macmillan and Co., 1895.)

YET another edition of White's "Selborne" has been issued by Messrs. Macmillan; and there are really some points about it which fully justify its appearance. It is in some degree an *édition de luxe*, being printed in beautifully clear type on thick glazed paper, and arranged in two neatly-proportioned volumes, which are fully illustrated.

The text is that of the Buckland edition. There are no editor's notes to speak of, and such of the "Observations," which it was thought desirable to include, have been inserted at the end of those letters to the subject of which they have reference. We have had many annotated editions, both good and bad, and probably no new one would tell us anything more concerning the subjects White wrote of in, or serve to elucidate further, the famous letters. Recent research has brought to light additional materials for a biographical sketch of White; but apart from this, we are inclined to dread the overdoing of the annotating—for overdone it assuredly was in some editions.

In his Introduction, Mr. Burroughs considers the reason of the longevity of this "cockle-shell of a book." He concludes that it is like plain food, neither exciting nor cloying; that, written by a born countryman, it has a home flavour about it. We are attracted by its sound style, and that precious sense of reality breathed in his sentences; by White's infinite curiosity, and his caution in making sure of his facts. But Mr. Burroughs is not quite just in one passage; it was *honey* dew, and not *heavy* dew, which White thought proceeded from the effluvia of flowers, although he was equally wrong in his supposition of the origin of that substance. Nor do we think that White succeeded finally in persuading himself that swallows in their ability to hybernate in a torpid state, stood on the same footing with bats and "turtles." As late as 1784 he had gone no further than considering the hybernation of house-martins probable. White received many facts relating to migration from his brother at Gibraltar, and in one letter we find him arguing in favour of migration in general with Daines Barrington, who was "no great friend to migration."

It seems to us that in this Introduction, one great charm of the "Natural History of Selborne" has been lost sight of.

White lived in England's golden age of leisurely prosperity, and it is just this air of leisureliness and freedom from any signs of hurry and worry, which gives his book its great charm, as its accuracy gives it its great value. In those days the man of small property who lived in a retired part of the country had practically no demands on his time, beyond such as he chose to make for himself in the direction of his garden, his live-stock, and his house. Society, as we understand it now, must have been unknown at that time to those who did not go to town. It was not necessary for White to pay calls, or to go to functions. A little "neighbouring" in the village and its immediate vicinity at convenient times, and some visits exchanged once or twice a year with well-tried friends, fulfilled all demands of that kind, although, as we see from the letters to the Barkers, White was fond of filling his house with friends and relations. There were in those days no stirring "movements" on foot, for the edification of men and women in the abstract, to claim his philanthropic attention, though we may be sure the needy of Selborne were not forgotten. To be well-read meant that a man might read the classics and a few favourite authors at leisure, instead of struggling with the stream of new books, with its ever-gathering strength and volume. White had not to acquire a smattering of a dozen sciences and a superficial idea of art, or to assimilate eight pages of a daily newspaper in order to fit himself to meet his enemy intelligently in the gate. At Selborne he had perfect leisure, and could bring an intellect, unstrained by his leisurely studies, to bear in unhurried observation on the comparatively limited outdoor objects of his quiet parish. Doubtless he had trained his observing eye and mind, as so many have trained them, in his sportsman days; and the habit of keeping a careful diary fostered accuracy in a mind naturally exact. It was, we imagine, his love of Selborne which prompted the production of his book; for if he observed much elsewhere, he did not note down his observations. Had he done so, we should surely have found in his letters more frequent references to the period of his residence at Oxford, then comparatively a leisurely place itself.

Undoubtedly the chief attraction in the present edition is the illustrations. For the first time we have a set which give us an idea of what Selborne village and neighbourhood are like. It is true that it is Selborne a century after White's death, which is represented, but we imagine that there must be much that is but little altered. We should have valued a few contemporary views very dearly. As we write, we have been turning over the leaves of another copy of the "Natural History," "a new edition with engravings," issued in 1822, and edited by John White, of Fleet Street. But the only illustration of scenery it contains is a view of the "grotesque building constructed by a young gentleman who used on occasion to appear in the character of an hermit." Some years ago it was our pleasant fortune to meet a relative and namesake of the author, who told us that the original of this sketch was still in existence. If there are any more eighteenth-century Selborne landscape pictures available, how admirably they would have embellished this edition! The illustrations in the two volumes, the subject of this notice—chiefly reproductions from photographs—will be heartily welcomed by those who love the book. Those who have made their pilgrimage will value them as a souvenir of their visit, while those who cannot go to Selborne will now have its quiet scenery brought to them. Though many changes have come to Selborne in the last hundred years, yet there must be some things left very much as White saw them. His house and his garden do not appeal much to us in the pictures, nor does the interior of the church, which seems to have suffered restoration, but we are very glad of his old sun-dial. Rick-building is a thing likely to be carried out conservatively in the local fashion,

while thatching is a rural fine-art handed down mostly from father to son. So it is probable that the corn-rick in Norton farmyard (p. 54) is similar in make and shape to that, for instance, under the thatch of which "were assembled near an hundred" harvest mice; although most probably in White's time all the ricks were erected on "staddles." The rick in the illustration is unlike the oblong square ones usual in some districts, and the round ones prevailing in others; it is square, and has the corners neatly rounded. There are some excellent views of the irregularly shaped thatched cottages, which are probably but little altered, and possibly the same may be said of the substantially-built houses seen when looking across the Plestor. The Plestor, the famous wooded "Hanger," and the Long Lythe—a favourite walk of White's—are quite familiar scenes in the mind's eye of White's readers. Views of Wolmer Pond and Wolmer Forest, once the haunt of wild red deer and black game, and where White found teal breeding, which he looked upon as "a great stroke in natural history," are very suitable illustrations, and we are charmed to have a picture of one of the "little round ponds" on the sheep-downs, which never dried up. But why insert a view of Stonehenge? White certainly mentions it; but so he does Oxford, Calabria, and other places which have nothing particular to do with Selborne. The figure of the "Rook-starver" (Rook-scarer) suggests the question whether this was a name of White's day. Most of these curious local names are old; but the Hampshire villagers must have differed from those of the Midlands, for instance, who invariably call rooks crows, and talk about "Crow-keeping." One of the prettiest views is that of an old cottage in the Lythe backed with clumps of hanging wood, and there is a very nice picture of a rookery.

There are a good many illustrations of birds, which in some, if not all, cases seem to have been reproduced from photographs of stuffed specimens. With hardly an exception they are quite as unsatisfactory as illustrations of this kind usually are, and some of them are exceptionally bad.

In the present edition the arrangement of the letters to Pennant and Daines Barrington in two separately numbered series is departed from, the whole being fused and arranged chronologically; this, especially to those used to the other style, makes the want of an index more felt. The second volume concludes with the new letters to members of the Barker family, and the Calendar.

O. V. APLIN.

PLANT PHYSIOLOGY.

Das Pflanzenphysiologische Prakticum. Von Dr. W. Detmer. Mit 184 abbildungen, zweite völlig neu bearbeitete Auflage. (Jena: Fischer, 1895.)

IN the new edition of this standard book, the general arrangement of the first edition has been for the most part adhered to, but in other respects great changes have been made. Nearly every section has been rewritten and enlarged, a large number of new experiments have been added, and in every case great care has been taken to give full details for carrying out the observations described. Among the sections added, the following may be mentioned: on the relation of the stomata to assimilation; an account of experiments on species of the natural family Papilionaceæ, illustrating their relation to the bacteria normally found in their roots; on nitrification, including an experiment on nitromonas, one of the remarkable organisms capable, without the action of light, of forming organic substances from inorganic materials. Another addition is the section on mykorhiza. In dealing with the intercellular system of plants, it is strange that Prof. Detmer still quotes the intercellular space, which accompanies the bundles of *Zea Mays*, as an example of a passage which is of importance in the exchange of gases and the aëration of the tissues; while it is almost certain that this passage is chiefly serviceable in conducting water in the plant. The sections dealing with transpiration have been materially enlarged and improved, although it is difficult to see how the author could be inclined towards Westermaiers and Godlewski's theories after Strasburger had so completely answered them. It is to be noted that, in an appendix, Prof. Detmer appears to accept the theory which regards the upward motion of the sap as due to the tension set up by the evaporation taking place in the leaves, and transmitted downwards through the water-columns in the tracheidal system. He, however, apparently by an oversight, attributes this theory to Prof. Askenasy, who himself, in the paper describing the theory, acknowledges the priority of its English authors.

In treating of the development of heat and phosphorescence by plants, much new matter has been added. The raising of the temperature of flowers above that of their surroundings, is doubtless often an attraction for their insect visitors; and it appears strange that phosphorescence should not be made useful in the same way, and that while many of the lower plants exhibit this phenomenon, yet in the flowering plants authentic instances of phosphorescence under normal conditions seem to be unknown. *À priori* we might consider that phosphorescing flowers would be very efficient in attracting night-flying insects for purposes of pollination, especially as this method of arresting attention is shown to be successful by several instances in the animal kingdom.

The portion of the book allotted to the movements of plants in response to stimuli, is clearly written, and contains accounts of much recent research in this field of plant physiology. Illustrating this subject, there is plenty of material for beautiful and striking experiments; perhaps one of the prettiest, described by the author, is an experiment on the chemotropism of the pollen-tube. A leaf of Tradescantia is injected with a sugar solution, and afterwards quickly washed in water and dried on the surface. On the under surface, which is rich in stomata, a number of pollen-grains are scattered, and the leaf thus treated is kept in a damp chamber. After a certain time it may be observed that the tubes of the germinating pollen-grains are each directed towards some one of the stomata, showing that the sugar solution in the stoma, and the intercellular spaces connected therewith, induces a chemotropic movement in the pollen-tube.

In its new form the book is certainly one of the most complete, if not the most complete, text-book of plant physiology. For although it is much smaller than Sachs'

classical "Lectures," yet it is so concise, that there is room in it to describe as many or more experiments than in the latter book; and it contains a great amount of recent work, which is naturally not to be found in the older text-book. The conciseness has, of course, its disadvantages, for in consequence of it the book is not so readable, nor is there space for the same philosophical treatment of the subject which is characteristic of the work of Sachs. Much, however, is done to lessen these necessary drawbacks by the clearness of the arrangement and the descriptions, and references to the original papers are in most cases given, so that the reader is presented with much of the literature on each subject. From these references the names of English authors are almost completely absent; this is in part due to the fact that, unfortunately, so few of our countrymen occupy themselves with plant physiology, and in part to the fact that, even when such work is to hand, the author often fails to allude to it.

Finally, the usefulness of the book is increased by a very complete index; and we are glad to learn that an English edition is in preparation. H. H. D.

OUR BOOK SHELF.

Science and Art Drawing: Complete Geometrical Course. By J. Humphrey Spanton, Instructor in Drawing, H.M.S. *Britannia*. Pp. 582, and 689 figures. (London: Macmillan and Co., 1895.)

THIS is a somewhat bulky but handsome well-printed volume, the title of which is a little unfortunate; it should, however, prove useful to students preparing for such examinations as those of the Science and Art Department, for the Army, or for Cooper's Hill. The author takes as a basis the South Kensington syllabus, and, by sundry additions, covers nearly the whole ground necessary for other examinations. The book is a trifle paradoxical, for while in the solid geometry information abounds, in the plane geometry the opposite is the case, and generally anything approaching to an explanation of the principles underlying the constructions has apparently been eliminated. This, we think, is a matter for regret, as a much larger sphere of usefulness would be obtained by a few judicious explanations, or by an occasional reference to Euclid; indeed, a step further might well be taken, and the equations of curves be given. The student would thus be familiarised with mathematical formulas, and by a little instruction would be enabled to follow the *rationale* of the construction instead of simply learning it by heart; for instance, the equation, $r = a + b \operatorname{cosec} \theta$, of the conchoid of Nicomedes (p. 183), shows at once the reason for the given construction being adopted. Such additions need not necessarily make the book more bulky, as the drawings on pp. 31–34, 60, 61, 78–80, and 164 might well be omitted.

The figures, which must of necessity form a distinctive feature in a work of this nature, are good throughout; those for the plane geometry, however, suffer by comparison with those of the remainder of the book, as the lettering of the former is not by any means neat; also, some of the diagrams illustrating horizontal projection are too small. For exhibiting the conic sections to junior students, the author hits on the happy method of cutting off, from the light of a candle, a cone of rays by means of a circular hole cut in a sheet of cardboard, and then by inclining another piece of cardboard across the cone the various conics are produced in shadow; later on, the conics are again discussed in an instructive manner as the sections of a cone. The author is not always fortunate in his definitions, and ambiguities occasionally occur; for instance, the spheroid (p. 13) is defined as "resembling the sphere in shape, but all its sections are not circles." Again with the conchoid (p. 183), we are told that "it has the *peculiar* property of always approaching nearer a straight line as it is produced, but would never meet it." From this it would almost appear that an asymptote occurred with the conchoid only, as it is never mentioned elsewhere, not even in connection with the hyperbola.

In the solid geometry the interest of the student is first excited with the plan and elevation of the simple solids; then a good chapter on spheres and spherical triangles is incongruously wedged in between this and the following chapters on points, traces of lines and planes, intersection of solids, &c.; the author faithfully following the South Kensington syllabus (omitting, however, any reference to perspective), and finally closes with elementary graphic statics, in which, by the way, a slight error has occurred in Fig. 331, the component (q) being shown in the wrong direction. The pages are remarkably free from error, and the book will no doubt fulfil a want felt by many for a practically complete course.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Discovery of the Anti-Toxin of Snake-Poison.

I DESIRE, without offering any comments on the facts, to bring under the notice of your readers the following simple statement.

In the *Annales de l'Institut Pasteur*, May 1894, Dr. Calmette described in full detail his researches on snake-poison, and demonstrated that not only can animals be rendered resistent to cobra (and other snake) poison by the injection into them of graduated doses of the poison (so that rabbits were rendered tolerant of sixty times the lethal dose), but that the serum of such immunised rabbits is found to contain a powerful anti-toxin which can be used successfully as an antidote to snake-poison. In April 1895, in the same *Annales*, Dr. Calmette described the results of a year's further work on this subject, giving the most important facts as to the antidotal action of snake anti-toxin in regard to poisons allied to snake-poison, and of other anti-toxins in regard to snake-poison.

On both occasions Dr. Calmette formulated his discoveries in such a way as to render them applicable to the treatment of snake-bite in man.

On June 3, 1895, Prof. Thomas R. Fraser, of the University of Edinburgh, read to the Royal Society of Edinburgh a paper (subsequently printed in the *Proceedings* of that Society) "on the rendering of animals immune against the venom of the cobra and other serpents; and on the antidotal properties of the blood-serum of the immunised animals."

In this paper, read more than a year after Calmette's first paper above cited was published, Prof. Fraser has refrained from any textual reference to Calmette's published work. His only mention of Calmette is as follows: "Within the last few months, Phisalix and Bertrand have obtained experimental indications of the antidotal power of the blood-serum of animals immunised, but only to a low degree, against the venom of vipers; whilst Calmette, working in the Pasteur Institute of Paris, after several unsuccessful endeavours had led him to express the opinion that immunity against snake-venom could not be produced, afterwards succeeded in obtaining evidence of its production, and of the power of the blood-serum to counteract the effects of venom."

The medical journals of Great Britain have represented Prof. Fraser as the discoverer of the anti-toxin of snake-poison. Two distinguished Edinburgh biologists—Prof. Geddes and Dr. Arthur Thomson—writing on Pasteur in the *Contemporary Review*, have put forward Prof. Fraser as one who has made an important life-saving discovery which is the latest fruit of Pasteur's fertile conceptions.

As a matter of fact, any one who will take the trouble to read Dr. Calmette's papers and Prof. Fraser's, will find that the sole credit of discovery in this matter rests with Dr. Calmette, who worked under the direction and with the suggestions of Dr. Roux.

It would be interesting to know whether the *Annales de l'Institut Pasteur* are accessible to Prof. Fraser, and whether he thinks that his vague reference to Calmette's detailed researches, and his designation of the interval between May 1894 and June 1895, as "a few months," are calculated to give to the British public a fair notion of the merit in this matter of his French colleague.

E. RAY LANKESTER.

Oxford, November 28.

The Maerjelen Lake.

A CORRESPONDENCE which I was recently the innocent cause of initiating in the *Standard*, revealed a very remarkable conflict of evidence touching the question of how often and to what extent the Maerjelen Lake[1] has of late years emptied itself. As I pointed out, the rare phenomenon of a total discharge of the lower basin through the Aletsch glacier recurred last September; whilst in the great majority of cases, a pool more or less deep is left in that basin, and the upper, more shallow basin is never quite empty.

Considering the grandeur of the emptying of the lake as an Alpine phenomenon, it might reasonably be expected that those who are fortunate enough to witness it, would take the trouble to note the dates and facts accurately. Such, however, is rarely the case, for many eye-witnesses are so led away by their enthusiasm at the time, and so deceived by their memory afterwards, that their evidence is often flatly contradictory, and hence of little or no value. This is strikingly illustrated by the public correspondence referred to, as well as by private letters and other information I have received since.

It would lead too far to enumerate all the vague and contradictory statements, both as regards dates and facts. Suffice it to mention that, while some eye-witnesses infer a total emptying of the lake simply from having seen a rush of water along the surface of the Aletsch glacier, others draw the same inference from the fact that they saw the lake empty. But neither of these inferences affords proof of a total discharge; for in the first case, only a partial discharge may have taken place, such as last occurred in September 1894, and in the second case, the lake, unless it was seen full the day or a few days before, may have been partially or completely empty for months. A partial emptying is of frequent occurrence; but the only true test of a total discharge, as authentically recorded, *e.g.* in 1864, 1878, 1887, and 1895, is the exposure of the glacier wall to its full depth of at least 150 feet immediately after the event. Some years ago, Prof. F. A. Forel gave a list of the recorded discharges (without special reference to partial or total discharges) up to 1890);[2] but even that list cannot, and, I believe, does not lay claim to completeness and strict accuracy.

The occurrence of September this year is of peculiar interest, because it shows that, notwithstanding the recently completed artificial overflow tunnel to the Viesch glacier, the Maerjelen Lake prefers its old outlet through the Aletsch glacier.

C. S. DU RICHE PRELLER.

The Former Northward Extension of the Antarctic Continent.

I SHOULD not presume to draw the attention of your readers to this much-discussed topic without having a new fact to contribute. The opportunity of loading still further the already overweighted scale which now dips so deeply in favour of the notion of a former northward extension of the Antarctic continent, has been afforded me by the kindness of Prof. Parker, F.R.S., of Otago, New Zealand. He has forwarded to me a few worms collected in Macquarie Island, which lies to the south of New Zealand, about half-way between it and the land of the southern continent. These belong partly to the almost world-wide *Pachydrilus*, and one species—a new one—is referable to the earthworm genus *Acanthodrilus*. The importance of this latter species is that it is firstly an *Acanthodrilus*, and secondly that it is closely allied to a group of Patagonian and South Georgian species of the same genus, and is less like any New Zealand form. It is to me a matter of surprise that Dr. H. O. Forbes, in his recent and important essays upon this question, has ignored the distribution of earthworms, which are so thoroughly wedded to the soil, and (except in a few cases) so impatient of sea-water. I have attempted to rectify this state of affairs in a text-book of zoogeography, lately issued by the Cambridge University Press. In Patagonia and some of the islands immediately to the southward, only two genera of indigenous earthworms, so far as is known at present, exist. These are *Acanthodrilus* and *Microscolex*. Of the former there are nine species, and of the latter five; but five species of *Microscolex* and two species of *Acanthodrilus*, in addition to those referred to, range northwards into Chili, which zoologically is indistinguishable from Patagonia. Let me emphasise the point that these are the only two genera which occur in these latitudes, save for a species or two of the European *Allolobophoba*, which is universal in range—thanks probably to direct exportation by man. In Kerguelen and Marion Islands but one species of earthworms has been found, which is an *Acanthodrilus*. In New Zealand there are nine species of *Acanthodrilus*, also six species belonging to genera that are very nearly akin to *Acanthodrilus*, and three species of *Microscolex*. The remaining six species of *Microscolex* are South and Central American to the extent of four, while the two remaining are from Tenerife and Algeria. Of *Acanthodrilus*, the only species left, after deducting those already enumerated, are one from the Cape of Good Hope, one from New Caledonia, and three from Western and North Australia. Besides these forms New Zealand possesses a single Perichætid worm and Schmarda's species, *Hypogæon orthostichon*, which I have recently (a "Monograph of the Order Oligochæta," Oxford, at the Clarendon Press) referred to the characteristically Australian genus *Megascolides*. It is clear that, if the former northward extension of the Antarctic continent is not believed, some explanation of these remarkable facts is much wanted; on that hypothesis they are perfectly explicable.

FRANK E. BEDDARD.

Zoological Society's Gardens.

The Feeding Ground of the Herring.

I HAVE no desire to set aside lightly the observations of Profs. Herdman, Brady, Scott, or any other scientific gentleman, as suggested by Mr. Calderwood in your issue of November 21. There is no evidence that these gentlemen have made any systematic examination of the deep waters of Loch Fyne, whereas I have carried out investigations of this kind during many years at all seasons under the direction of Dr. Murray and Dr. Mill, and I think Prof. Herdman set these observations very lightly aside in his Ipswich address.

If various kinds of tow-nets be dragged through the surface waters of Loch Fyne, down to a depth of 20 fathoms, at the present time of the year, probably not a single specimen of red-coloured *Calanus*, *Euchæta*, *Nyctiphanes*, or *Boreophausia*, will be captured, and these animals I hold make up nine-tenths of the bulk of the food of the herring in Loch Fyne. If the same nets be dragged near to the mud at the bottom in depths between 70 and 100 fathoms, immense numbers of these Crustaceans will be taken; and this state of matters practically holds good throughout the whole year, these Crustaceans being always found at the bottom and rarely at the surface. It occasionally happens, however, that at quite local spots some of these deep-sea Crustaceans rise or are drawn up to the surface, and being carried out of their natural habitat are killed there, and are blown upon the shore, where they form a red line along the beach. It must be remembered, however, that this is quite an exceptional occurrence. On several occasions we wished to send to Inveraray living specimens of *Nyctiphanes*, in order that their brilliant phosphorescence might be exhibited. These were captured in large numbers in the trawl sent down to 70 fathoms, but we found that they were all killed as soon as they were put into the jars, which we afterwards found had been filled with the somewhat fresh water floating on the surface of the loch; it was only by collecting water from the deeper layers that a few specimens could be preserved alive. On other occasions, after a long spell of dry weather, there was no difficulty in keeping large numbers of *Nyctiphanes* alive for a long time, and on one occasion I conveyed many bottles filled with these Crustaceans to Edinburgh, and exhibited them at an evening meeting of the Royal Society.

The very fact that Mr. Calderwood was able to scoop up red-

[1] *Vide* NATURE, 1887, vol. xxxvi. p. 612. T. G. Bonney.
[2] "Variations Périodiques des Glaciers des Alpes." S. A. C. 1890, p. 358.

coloured *Calanus* on the beach with his hand, shows that these creatures had passed through some unfavourable conditions. Dr. Murray has endeavoured to show that these deep-sea animals are brought to the surface through the movements of large bodies of water during gales or during calms following gales. However this may be, their proper habitat is certainly at the bottom. When they do come to the surface they form oily-like streaks or small spots, where herrings and other fish and birds may be seen feeding upon them. The *Nyctiphanes* at any rate remain but a very short time at the surface. On one occasion in Kilbrennan Sound we were attracted to a spot where guillemots, gulls, and other birds were feeding, and we found that their stomachs were filled with perfectly fresh *Nyctiphanes*, and the *Nyctiphanes* themselves could be distinctly seen on the surface for a short time. The fishermen shot a circle trawl-net around this spot, and procured twelve boxes of herrings, the stomachs of which were distended with these Crustaceans in all stages of decomposition. I can show these stomachs to any one visiting this Station.

In my previous letter I mentioned that we had captured herrings in the deep water with their stomachs filled with these Crustaceans, and skate, which feed at the bottom, have been taken in depths over 50 fathoms with herrings in their stomachs. When the herrings' stomachs are filled with adult *Nyctiphanes*, as above stated, the herrings are not commonly called "gut-poke," or at least are not looked upon as diseased. The so-called disease is attributed to those herrings which have been feeding chiefly upon the young *Nyctiphanes*, or "black-eye."

I do not claim that there is anything new on this subject in my letters, nor do I see anything new in that of Mr. Calderwood, except the statement that Copepods alone are the cause of the the so-called "gut-poke" disease, which I do not believe. The whole of this information was published many years ago. In a lecture delivered in November 1887, as reported in the *Scotsman* of November 23, Dr. Murray said regarding the "poke-gut":—

"There was also a kind of herring called the 'poke-gut' herring, which was supposed to be suffering from some disease or complaint. This was a herring whose stomach was distended with food, which consisted of one or other of the minute animals to which he had referred. One of the commonest things to be told on the west coast was that the 'poke-gut' herrings were not fit for food, and would not cure. The fishermen told them that they had eaten some 'black stuff,' the effect of which was to make them sick, that it burned a hole in their bodies, and acts as if they had eaten quicklime. For a long time he was very doubtful as to what the explanation of this belief could be, but he ultimately found that the cause of it was this—that the poke-gut herrings had been feeding on the young *Nyctiphanes*. The eyes of these creatures are very black indeed (as Dr. Murray showed by exhibiting a bottleful of the creatures in a preparation of glycerine), and an accumulation of these in the stomach of the herring gave the whole contents a very black aspect. On being taken into the boat, decomposition set in very rapidly, the lining of the stomach was speedily eaten away, and before long an actual hole, as the fishermen said, was made in the body, out of which this black mass exuded. In this 'poke-gut' state the herring, however, was simply engaged in laying up a store of fat, the nutritive processes of the animal being then exceedingly active. When it had laid in this store of fat, the herring then sought the shallow waters of the shore for the purpose of depositing its spawn. Mr. Hoyle spent several months at Peterhead examining the stomachs of the herring to ascertain what they fed upon during the fishing season, but the result of his investigations was that he did not find in any one of them a full meal. Similar results were obtained by Mr. Beddard at Eyemouth, and by Prof. Herdman on the coast of Arran."

Our observations on board the *Medusa* went to show that the "poke-gut" condition of the herring was chiefly due to the large number of young *Nyctiphanes* contained in the herrings' stomachs, but Mr. Calderwood makes no mention of any Crustacea beyond Copepods.

ALEXANDER TURBYNE.

Scottish Marine Station, Millport, Cumbrae, November 29.

The Theory of Magnetic Action upon Light.

I HAVE already pointed out that the various questions relating to the theory of the action of magnetism upon light cannot be disposed of by arguments based upon vague and obscure general reasoning, but require a careful mathematical investigation for their elucidation. I therefore propose in the present letter to state, as briefly as possible, the results to which an examination of Mr. Larmor's theory leads, and to show how my own theory may be amended so as to remove the objection concerning the discontinuity of the E.M.F at an interface.

I find that Mr. Larmor's theory requires that all the equations of Maxwell's general theory of the electro-magnetic field should remain unaltered, except the equation

$$P = -F - d\psi/dx,$$

which must be modified by the insertion of the additional terms

$$-p_3\zeta + p_2 h + z d\phi/dy - y d\phi dz \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where p_1, p_2, p_3 are constants depending on the magnetic field, and φ is a potential function.

The first two terms are equivalent to introducing Hall's effect; but for the last two there is no justification whatever. They are not required in optics nor in electro-magnetism. These results, combined with Larmor's boundary conditions, prove my statement that his theory makes the tangential component of the E.M.F. *discontinuous* at an interface.

In the next place, a satisfactory theory may be constructed by modifying Maxwell's relation between E.M.F. and electric displacement, keeping all the other equations unaltered. The proposed modification is

$$P = 4\pi f/\kappa + p_3\zeta - p_1 h \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

It will be found that this hypothesis leads to exactly the same equations of motion and boundary conditions as those given in my paper in the *Phil. Trans.*, 1891; but that, in consequence of the relation (2), the tangential component of the E.M.F. is *continuous* at an interface. The other boundary condition is, continuity of the tangential component of the magnetic force.

According to Maxwell's theory, the electrostatic energy is given by the expression

$$\tfrac{1}{2}(Pf + Qg + Rh);$$

and if we assume that this result holds good when P is given by the modified form (2), it will be found that all the results can be deduced by means of the principle of least action.

Under these circumstances, I think I may justly claim to have placed the theory of Kerr's experiments on as perfect a basis as is possible in the existing state of electrical science.

A. B. BASSET.

Fledborough Hall, Holyport, Berks, November 29.

The Barisál Gun.

I HAVE read with interest Dr. Darwin's communication, in NATURE for October 31, on "The Barisál Guns and Mist Pouffers," and his request that the readers of your journal should give accounts of their own experiences in this matter. I refer him to the *Theosophist* magazine, vol. ix. p. 705, and vol. xi. p. 409, for two articles upon my personal observations at Barisál village itself, in the Gangetic delta. All the various theories until then propounded by men of science to account for the phenomenon in question were severally reviewed and pronounced inadequate. I had intended writing a third and final article, but found it impracticable to throw any further light upon this most interesting problem, and so abstained. Dr. Darwin is quite wrong in supposing that the sound of the "Barisál Gun" is "dull and distant," and that "it does not resemble artillery." However the like sounds may seem to the Ostend lighthouse-keeper, they were so sharp and loud that I thought the "evening gun" was being fired at a cantonment in the village, and asked a friend standing by if that were so. I shall not encroach on your space to go into details, since the back volumes of the *Theosophist* may be consulted at the British Museum, and Dr. Darwin will make such use of them as he sees fit.

H. S. OLCOTT.

Adyar, Madras, November 20.

Remarkable Sounds.

IN connection with Profs. McKenny Hughes and J. P. O'Reilly's letters on the above subject, suggesting the collection of data as to the distance the sound of blasting, &c., has been heard, it may be interesting to state that the blasting operations in the Charnwood Forest quarries (probably Bardon Hill) can be distinctly heard on the higher ground to the south-west of Atherstone, a distance of about eighteen miles. From the intensity of the sound, I have little doubt that under favourable conditions it may be heard very much further.

Geological Survey, Leicester. C. FOX-STRANGWAYS.

Flight of Birds Across the Moon's Disc.

ON the evening of October 7, 1895, while observing the passage of the moon through the Pleiades for occultations, my attention was attracted by a flight of birds across the moon's disc. This continued with more or less regularity the whole time I was at work, from 7.30 to 9.30, the birds usually crossing singly, but sometimes in groups of two, three, or even four. In all, I saw perhaps 50 or 60; assuming a like frequency during the intervals when I was not at the telescope, from 200 to 250 must have crossed the disc during the two hours. All were flying south with a single exception. Their outlines and the flapping motions of their wings were very distinct; none were soaring. The telescope is a 12-inch refractor: eyepiece of power 90. The moon was low, its altitude ranging from 5° to 15°.

The time occupied in transit varied from four to eight seconds, the difference in apparent size being very marked, and the larger always taking the less time. Assuming a rate of twenty miles an hour for their flight, the distance would be about 5 miles for a bird making a transit in eight seconds, or $2\frac{1}{2}$ miles for four seconds. Taking into consideration the altitudes of the moon when the above transits were timed, the corresponding altitudes of the birds above sea-level ranged from 2700 to 5000 feet. Considerations as to its size make it probable that these figures are none too small. It may be of interest to note that the Observatory stands on a promontory jutting out about 5 miles from the general trend of the Syrian coast, and that according to these calculations the birds were flying either just along the coast-line or over the sea.

I may add that, in addition to Mr. Bray's experience, given in NATURE, No 1348, several accounts of similar observations are given in Newton's "Dictionary of Birds," with estimates of altitudes, ranging, for the most part, much higher than those given above.

ROBERT H. WEST.

Syrian Protestant College, Beirut, November 25.

A Luminous Centipede.

RETURNING home on a very dark evening a few days ago, I saw on the ground a greenish phosphorescent light which, in the distance, I took to be a glowworm (*Lampyris noctiluca*), but a nearer approach showed a luminous thread-like worm of $1\frac{1}{4}$ inches in length, moving in curves along the gravel drive. I stooped and placed a finger and thumb on either side of the glowing thread without actually touching it, and in a few seconds observed that, aware of danger either from scent or vibration, the insect showed a remarkable power of control over its luminosity, invaluable for protection. It began to extinguish its light, and in a most peculiar fashion, not dying slowly out all over, but with a rapid wave of darkness sweeping from the tail to the head, then in a second or so glowing brightly all over again, repeating the manœuvre several times so long as my finger and thumb remained in its vicinity. A glass was brought, into which I transferred the insect, where it glowed with a lessened light for three or four hours. The next night the phosphorescence was very feeble, and on the morning following the insect was dead.

Seen in the daylight my capture appeared to be a thin thread-like centipede, orange coloured, furnished with a fringe of fine hairs on either side of its many-segmented body.

ROSE HAIG THOMAS.

The White House, Basildon, November 27.

THE above communication certainly refers to one of the luminous centipedes of the family *Geophilidæ*; and since the species that most commonly draws attention to itself in England by the exhibition of phosphorescence is of a reddish-orange colour and is known as *Linotænia crassipes*, there is no reason to doubt that the specimen under discussion was an example of this species. The property of luminosity lies in an adhesive fluid secreted by glands which open upon the lower surface of the body, and the power of discharging or retaining the fluid appears to be entirely under the centipede's control.

The phenomenon is observable during the autumn months, from about the middle of September to the end of November, and although its significance is not clearly understood, it is generally believed to be connected with the pairing of the sexes.

R. I. POCOCK.

The Critical Temperature of Hydrogen.

IN the October number of the *Proc. Phys. Soc.*, Mr. "G. H. B.," after quoting Wroblewski's paper "Die Zusammendrückbarkeit des Wasserstoffes" (*Wiener Sitzb.*, 1889), says (referring to my paper "On the Critical Temperature of Hydrogen," *Bull. Acad. Cracovie*, March 1895): "Natanson does not appear to have made any fresh experiments on the subject, and the conclusions arrived at in his paper are therefore not results of independent original investigation." It is difficult to understand the right Mr. "G. H. B." has to ignore the professedly *theoretical* character of my paper. To blame a writer offering theoretical deductions on the account of his not having made "fresh experiments," is surely a criticism of extraordinary character. Wroblewski's critical data are not in the least the outcome of direct experiment, but have been calculated from an empirical equation, constructed to represent Wroblewski's compressibility curves. My reasoning and calculation are *utterly different*, being founded upon Van der Waals' law of thermodynamic correspondence. Besides, there are other points in my paper, and they have no relation with whatever Wroblewski has written. All this will be seen at once on comparing my paper with that of Wroblewski's. But from Mr. G. H. B.'s own words, it must be inferred that, before publishing what implies a serious accusation, he did not take the trouble of looking with his own eyes at Wroblewski's paper.

LADISLAS NATANSON.

Cracow University, November 28.

A METEOR PHOTOGRAPH.

THE accompanying photograph (p. 132) was obtained on Saturday night, November 23, about 12h. 15m., by Mr. C. P. Butler, at Knightsbridge. With the intention of focussing and testing the field of a new lens, he had placed a quarter-plate camera on the window-sill, pointed it roughly at the region near the boundaries of Perseus, Andromeda, and Aries. He was necessarily in darkness during the exposure, but uncovered the plate about 12h. 10m., and terminated the exposure at 12h. 20m., so that the limits are close enough for recognising the meteor if it chances to have been recorded elsewhere. On developing the plate on the following Monday, the track of the meteor was the first impression to be perceived, and, not knowing of its occurrence during the taking of the photograph, it was thought that the plate had by some mishap been spoiled. Having finished developing, however, and after fixing, it was seen that this was not the case, the strange appearance being evidently an image of some meteor flashing past during the exposure. The star trails (the camera was fixed, so the stars are represented by short lines about an eighth of an inch long) are all distinct, but owing to the region included in the field being almost barren of bright stars, with the exception of α, β, and γ Arietis, which come in at the edge of the plate, they are too minute to bear reproduction.

Confirmation of the occurrence of the meteor is given by its having been observed from the South Kensington Observatory, both the time of fall, 12h. 15m., and the estimated region of its path being identical with the above observations.

As near as can be estimated, on consulting the region on the star map, the meteor appeared some distance south of the interval between Perseus and Aries, in the area enclosed by α, γ, ξ^2 Ceti, and fell downwards. It would probably be one of the Andromedes, which were due to occur on the 23rd ult.

It was described as being as bright as Jupiter, and leaving a long trail. This is fully borne out on carefully examining the negative, or the accompanying enlargement, which is about six times the size of the original. Much additional light is thrown on the phenomena attending the passage of a meteorite through our atmosphere, as at present all that is known rests on the results of visual observations, which may be greatly deceptive in the case of such rapidly-moving objects.

The image, in comparison with those of stars of known

magnitude, proves the body to have been at least of magnitude − 1, and at the time of greatest brilliancy this s probably an under-estimate.

PHOTOGRAPH OF A METEOR.

It begins very faintly, showing the initial contact with the atmosphere, and, gradually increasing in brilliancy until it has travelled about $1\frac{1}{2}°$; it is evident that about this time an explosion occurred, the details of which are well recorded on the photograph. The products of the detonation are seen spread out in all directions round the central mass, but the main portion again takes a definite path; not, however, in the original direction of the meteor's flight, as can be readily seen on reference to the photograph.

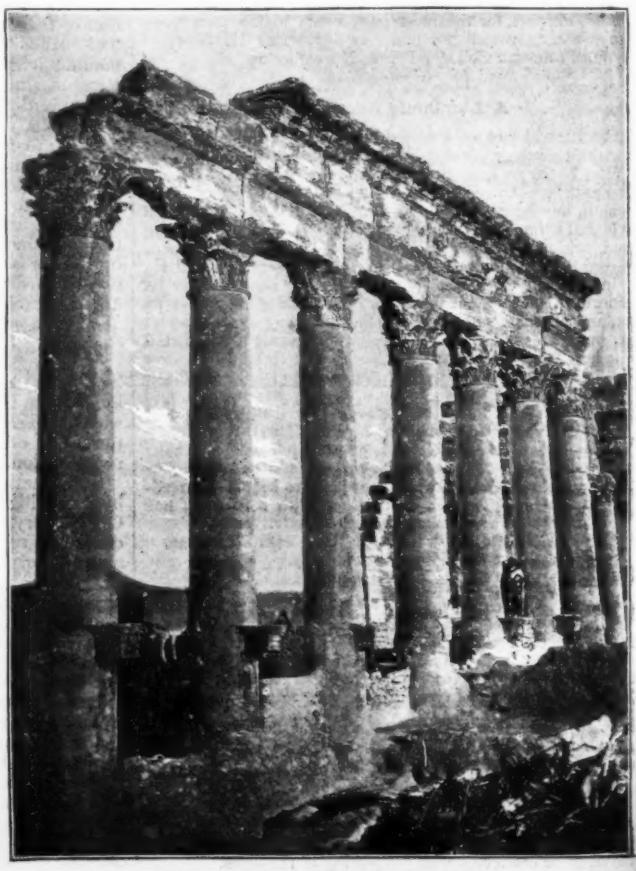
This is probably due to the body being of such a nature as to resist disruption in some directions more than others, and so the resultant of the initial velocity and the new velocity, due to the recoil of the main mass, might lie in some other direction than that of the original path. This has been the case here. If, as an approximation, we take its first appearance to have been at a height of sixty miles, the extreme diameter of the area occupied by the matter expelled during the explosion would be a little more than a mile. The brightest portion of the streak is about $3\frac{1}{2}°$ long, but the fainter trail may be traced for a considerable distance beyond, becoming at last too faint to affect the sensitive plate.

THE ROYAL CITY OF ZENOBIA.[1]

LIKE all ancient cities of the East that have once been centres of trade and culture, but are now only marked by piles of ruins and a few squalid huts, Palmyra has a strange fascination. Though on the edge of the Syrian desert, the site of this ancient city is but five days' journey from Damascus, so that her ruins have been thoroughly explored, her inscriptions copied, and all facts that might be of interest to the man of science, the archæologist, or the historian, have been obtained from her. On opening Dr. William Wright's "Palmyra and Zenobia," therefore, we did not look to find anything very startling or original.

From internal evidence of his work, we gather that Dr. William Wright, who must not be confused with the late Prof. William Wright of Cambridge, is connected with a Protestant missionary society, and from his preface we learn that he was resident in Syria for nine years. It was, perhaps, in consequence of his duties at Damascus that he was unable during this period to break fresh ground in his excursions from that city, and had to be content to follow the more beaten tourist track. His book, in fact, contains an account of two visits to Palmyra, one in 1872, the other in 1874; and as neither of these was of very long duration, we must congratulate him on the production of the present work. The latter part of the book records a trip to the south of Damascus as far as Bosra.

His account of his experiences on the road is amusingly told, and to many will be novel, for Syria is not yet so well known as Switzerland; but what Dr. Wright regards as "adventures," would perhaps appear to the veteran explorer as somewhat ordinary incidents of travel. His description of the ruins, however, and his sketch of the history of Palmyra, though a little superficial and wanting in arrangement, is in the main trustworthy and will, no doubt, prove attractive to many readers. On one occasion the author drops his *rôle* of gossipy narrator, and inserts on p. 124*f.* two Palmyrene inscriptions, to



COLONNADE OF THE TEMPLE OF THE SUN.

[1] "An Account of Palmyra and Zenobia, with Travels and Adventures in Bashan and the Desert." By Dr. William Wright. (London: Thomas Nelson and Sons, 1895.)

which he appends translations. The inscriptions appear to have been reproduced from De Vogüé's "Syrie Centrale," pl. 4, Nos. 28 and 29, and the translations are versions of the French rendering to be found on p. 28 *f.* of the same work. We do not blame Dr. Wright for this apparently learned insertion, as no doubt many of his readers would be interested in seeing what a Palmyrene inscription looks like; but we do think he should have given some reference or indication of the source from which he took his information. It is the more to be regretted that he omitted to do this, as in his translation Dr. Wright has written "the daughter of *Zabbai*" for *Bath-Zebhīnah* of the original, not recognising the proper name, Ζηνοβία, in its semitic dress—an odd mistake to come across in a book which claims to give an account of that great queen.

In a book of travel one does not expect any remarkable purity of style, but Dr. Wright has perhaps too great a liking for fine language; as, for instance, when he describes a lady out riding as "bounding over the desert on a splendid charger, whose neck of thunder swayed hither and thither to her silken touch." But this is a minor detail, and, although we cannot honestly say that the man of science or antiquary will gather any particularly new or useful information from his pages, it would be ungenerous to discourage any one from describing, for the benefit of other people, the places and incidents from which he himself has derived pleasure. The book, in fact, would form a chatty and by no means uninteresting companion to any more solid work on the same subject, such as Socin's "Palestine and Syria," published by Baedeker, in which all historical and topographical facts concerning Palmyra and Syria in general are carefully arranged. We may add that the volume before us is prettily bound, well printed, and has plenty of illustrations, two of which are here reproduced. The one gives a view of a colonnade from the Temple of the Sun at Palmyra, while from the other some idea can be obtained of the forest of columns which are still standing on the site of that once famous city.

TRIUMPHAL ARCH, WITH CASTLE IN THE DISTANCE.

NOTES.

THE Council of the Pasteur Institute are about to organise a committee to make an international appeal for funds to erect a statue of Pasteur in Paris.

AN expedition to observe the solar eclipse next August will be sent out to Yezo from Amherst College, U.S.A., under the direction of Prof. David P. Todd. The expedition is expected to leave San Francisco next spring.

IT is reported by Reuter that steps are being taken to invite the Prince of Wales and the Secretary of State for the Colonies to visit Toronto in August 1897, when the British Association meets there, to open the new municipal buildings, which by that time will have been completed at a cost of £500,000.

AN Electrical Lighting and Power Act has recently been passed at the Cape of Good Hope, authorising regulations for the safety of the public. Mr. A. P. Trotter has been appointed Government Electrician and Inspector under this Act.

THE deaths are announced of Dr. A. J. Woïtow, Professor of Bacteriology at Moscow; Dr. Ludwig Rütimeyer, Professor of Zoology at Basel; Dr. F. P. Porcher, of Charleston, South Carolina, author of numerous works on pharmaceutical botany.

THE Executive Committee of the City and Guilds of London Institute are inviting applications for the appointment to the Salters' Company's Research Fellowship for the ensuing year. The Fellowship was founded by the Salters' Company for the encouragement of higher research in chemistry in its relation to

manufactures, and particulars of the scheme under which the award is made may be had on application to the Honorary Secretary, at the head office of the Institute, Gresham College, Basinghall Street, E.C. The results of the researches by Dr. Martin O. Forster, the Salters' Research Fellow for the current year, at the Institute's Central Technical College, were communicated to the Chemical Society at its last meeting.

A NUMBER of the former students of Prof. Bonney's Geological Classes at the University of Cambridge, and at University College, London, have united to present him with his portrait as a memento of their personal esteem, and in recognition of his labours among them, and of his services to geological science. The portrait will be presented to Prof. Bonney on Monday, December 16, at 3.30 p.m., at University College, Gower Street. The work has been executed by Mr. Trevor Haddon, of the Abbey Studio, 18 Great George Street, Westminster, where it will be on view on Friday and Saturday, December 13 and 14, from 10 to 4. A platinotype reproduction of the picture has been prepared under the supervision of the artist, who will be glad to afford further information.

THE following are among the lecture arrangements at the Royal Institution before Easter:—Prof. J. G. McKendrick, six lectures (adapted to a juvenile auditory), on sound, hearing and speech; Prof. Charles Stewart, eleven lectures on the external covering of plants and animals: its structure and functions; Prof. H. Marshall Ward, three lectures on some aspects of modern botany; Lord Rayleigh, six lectures on light. The Friday evening meetings will begin on January 17, when a discourse will be given by Lord Rayleigh, on more about argon; succeeding discourses will probably be given by Prof. Burdon Sanderson, Mr. W. S. Lilly, Dr. John Murray, Mr. J. J. Armistead, Dr. Edward Frankland, Mr. A. R. Binnie, Mr. Sidney Lee, Prof. T. R. Fraser, Prof. Dewar, and others.

THE Government of India has resolved to establish an imperial bacteriological laboratory at Agra, under the directorship of Prof. Hankin, and an imperial chemical laboratory in Calcutta. According to the *British Medical Journal*, health officers are to have a six months' training in bacteriology; special diplomas, after careful training in hygiene, are to be granted by the colleges, and 1900 municipalities will be expected to appoint trained men for sanitary work. To make the scheme complete, further laboratories will probably be organised on a smaller scale in each of the great Indian presidencies, and arrangements will be made for giving six months' training of medical officers in the service. The scheme, when completed in details and in course of time, will give to India a perfect sanitary organisation and service.

THE fireball of November 22, which formed the subject of letters in NATURE of November 28 and December 5, attracted the attention of a large number of observers. Mr. W. B. Tripp, writing from Isleworth, says the meteor was observed there at about 6.50 p.m. Mr. J. H. A. Jenner noted the spectacle at Lewes at the same time, and remarked that the trail was visible for two or three minutes, and remained quite straight until it disappeared. He adds: "The path of the meteor was along the eastern sky from south to north, following a line from about the centre of the constellation Perseus towards α Ursa Major. The colour of the ball itself was reddish, and the motion seems to have been comparatively slow." This meteor was seen also t Chichester and Dover. At the latter place, the time noted by Mr. W. H. Pendlebury was 6.53 p.m., and the light emitted was said to have been "sufficiently brilliant to throw the electric light into shadow, while the glow remained visible for between one to two seconds."

FROM a letter addressed to Mr. R. H. Scott, by Dr. J. Hann, we are glad to learn that the Austrian expedition for the Society's exploration of the Red Sea has succeeded in establishing meteorological stations at Jedda, Kosseir, and Brothers Islands, about forty miles off the coast of Upper Egypt, and has provided them with self-recording barometers. At the latter station the observer is a Norwegian, in charge of the lighthouse. It is hoped that the observations will be continued for at least two years, and will furnish an important contribution to the meteorology of the district. Observations have been made at the Dutch Consulate at Jedda for some years, and by the Italians at Massowa, but, generally speaking, observations at land stations in those parts are scarce. The expedition will investigate the southern parts of the Red Sea, between Jedda and Massowa, during the winter months, and we learn that the zoological collections have up to the present time been very satisfactory.

ZOOLOGISTS will be glad to note that the editor and publisher of the *Zoologischer Anzeiger* have recently announced the steps which they are prepared to take in conjunction with Dr. Haviland Field towards a reform of existing bibliographical methods. With the new year the *Zoologischer Anzeiger* will be to some extent remodelled. It will retain its present mode of publication in approximately fortnightly numbers, as well as its division into two sections, independently paged, one dealing with scientific communications, and the other with current literature. But complete volumes of the *Anzeiger* will no longer take the form of annuals. They will be determined simply by bulk: forty sheets of "Wissenschaftliche Mittheilungen" and forty sheets of "Litteratur" will together compose a volume. The "Litteratur" section, moreover, will be obtainable in three different forms: (1) the ordinary edition, (2) an edition printed on one side of the paper only, and (3) a ticket-edition, suitable for the formation of card-catalogues. The two first editions of this "Bibliographia Zoologica" will be issued from the office of the *Zoologischer Anzeiger* in Leipzig, but the ticket-edition will be exclusively issued from the office of Dr. Field's International Bibliographical Bureau in Zürich. This combination of Dr. Field's and Prof. Carus's forces should prove of great service to students of every branch of zoological literature, which in these latter days has attained such enormous dimensions.

IT is now nearly twenty years since the brilliant, if brief, career of *Bathybius* was extinguished by the discovery that this primordial organism was in fact no organism, but a colloid precipitate of calcium sulphate produced by the action of alcohol on sea-water. Ten years later, however, *Bathybius*, or its next of kin, seemed to come to life again in the form of a remarkable protozoon parasite discovered by M. Moniez in the body cavity of certain small fresh-water Crustaceans (Ostracoda and Cladocera), and named by its discoverer *Schizogenes parasiticus*. This creature was described as an irregularly shaped disc of homogeneous, slightly refractile protoplasm, which showed no differentiation into zones and contained no nucleus, no contractile vacuole, and no granule of any kind. It was stated to exhibit a certain power of movement, and to reproduce itself by fission or constriction. It would appear, however, that *Schizogenes* is not to escape the fate of its more illustrious predecessor. Dr. G. W. Müller, well known by his monograph on Ostracoda in the Naples series, has found that the *Schizogenes* of the Ostracoda is no organism, but the viscid chitinous secretion of the so-called shell-gland. (*Zool. Anz.*, No. 486.) The secretion shows the different shapes and movements characteristic of *Schizogenes* owing to the absorption of water. *Schizogenes* can, in fact, be created at will by compressing the fresh shell-gland of an Ostracode in water beneath a cover-slip.

IT has been shown by several investigators that luminous vibrations of short wave-length are capable of producing an inflammation of the skin. It is, therefore, easy to understand

that such actinic rays increase an inflammation already existing, as is the case in small-pox. The latest contribution to the knowledge of this action appears in the *British Medical Journal*, in which Dr. N. R. Finsen, of Copenhagen, gives the results obtained by keeping small-pox patients in non-actinic light. The following are the main points concerning the treatment:—(1) The exclusion of the chemical rays must be absolute; even a brief exposure to daylight may produce suppuration and its sequelæ. In other words, the skin during small-pox is as susceptible to daylight as a photographic plate, and must be kept from the chemical rays in the same way and almost as carefully. If, therefore, red window glass is employed, it is necessary for it to be of a deep red colour, and if curtains are used, they must be very thick or in several layers. When the patient takes his meals, or during the physician's rounds, artificial light—for instance, faint candle-light—may be used without any danger. (2) This method does not prevent but allows the employment of any other treatment which may be considered necessary. (3) The treatment should be commenced as early as possible; the nearer the commencement of the suppuration the smaller the chance of success. (4) The patient must remain in the red light until the vesicles have dried up.

ONE of the difficulties which attends the production of the new serum remedy for diphtheria is the uncertainty which accompanies the elaboration of toxic products by the diphtheria bacilli in culture media. This diphtheria-toxine, as it is called, has to be produced on a large scale, and it must be of a requisite degree of virulence, or it will not, when subsequently inoculated into horses, endow the blood-serum of the latter with the necessary degree of diphtheria-immunising properties. Even the bacilli taken direct from the throat of a diphtheria patient are not capable of elaborating, in culture media, toxines of a sufficient strength for the purposes of anti-diphtheritic serum production, and recourse has to be had to increasing their virulence by first inoculating them into guinea-pigs, and then transferring them to the culture media. The reason of this most inconvenient idiosyncrasy, so characteristic of diphtheria bacilli, has until recently not been surmised, but Prof. Spronck of Utrecht has unravelled the mystery in a most interesting manner.

THE last number of the *Archives des Sciences Biologiques*, published by the Imperial Institute of Preventive Medicine in St. Petersburg, gives the annual report on the anti-rabic inoculations carried out during the past year in St. Petersburg and Odessa respectively. In St. Petersburg, 224 persons were treated by Pasteur's method, and only three succumbed to hydrophobia. In two of these cases death ensued during the treatment and before, therefore, the inoculations had produced their full effect; in the other case, the patient was not treated until thirteen days after he had been bitten, and he died just three weeks after the inoculations had been completed. Amongst the rabid animals, 193 were dogs, 18 wolves, 7 cats, 5 horses, and 1 pig. At Odessa, no less than 984 persons were inoculated anti-rabically, the larger number of persons so treated being between twenty-one and forty years of age. The death-rate from hydrophobia, including those persons who died before the treatment was completed, was equal to 0·32 per cent. An instance is recorded of a death from hydrophobia having taken place one year after the anti-rabic inoculations were completed. The patient was severely bitten on his hands by a mad dog, and presented himself a week later at the Institute, although the wounds had been cauterised three hours after their infliction; the inoculations were completed on July 14, 1893, and on July 15, 1894, he died of hydrophobia. At Odessa the largest number of cases were admitted in the months of May, June, and July; but at St. Petersburg, contrary to the usual experience, the maximum number of patients were received in the spring and autumn respectively.

A NUMBER of interesting observations of the habits of the common bat and the long-eared bats in captivity are recorded by Mr. John D. Batten in *Nature Notes* for December. Common bats appear to be practically blind, yet Mr. Batten mentions that he never knew a bat fly against a window or against any obstacle: light or darkness apparently making no differences in its flight. Long-eared bats appear to see better than common bats, and their hearing is much more acute. There is seldom any difficulty in inducing bats to feed. Mr. Batten fed his bats at first on flies, moths and grasshoppers, but when these became scarce, he fed them almost entirely upon meal-worms. It is remarkable that bats, on being captured, readily adopt an entirely new method of life, and the new habits thus acquired quickly become natural. When bats are asleep in October and November, they take sometimes as long as a quarter of an hour to awaken. Mr. Batten has observed the process carefully, and finds it to be always the same. He thus describes it: "The bat when thoroughly asleep is cold, dead cold to the touch. If I then took it in my hand it would not attempt to move about or seek for food, but lie quite still. On putting it to my ear I could hear a throbbing begin, at first very slowly and not very regularly, more than a second between the beats. Gradually the throbbing became quicker and quicker until it was impossible to count the beats, at the same time the warmth of the body was increasing very rapidly, and the bat quivering visibly. At last the throbbing becomes a continuous whirr, not unlike the purring of a cat, and the body feels quite hot to the hand. Then, rather suddenly, the throbbing quiets down like water coming to the boil, it slows somewhat, and becomes almost inaudible. The bat coughs or sneezes, chatters a little with its teeth, and begins to move about expecting to be fed." Of three bats set to hibernate at the end of November in 1890, two were found dead at the end of the following January, and one was alive and perfectly strong; its fur was in good condition, and it fed well, and the hibernation had not affected its power of flight.

THE occurrence of perlitic cracks in a rock of stony texture has always been held as evidence of its alteration from an originally glassy state; but within the last two years doubt has been cast on this conclusion through Mr. W. W. Watts's observations on the pitchstone of Sandy Braes, in which perlitic cracks were claimed as traversing the quartz and other crystals as well as the matrix. In a paper read before the Royal Society of New South Wales, Mr. W. F. Smeeth has, in connection with a description of a local pitchstone resembling that of Sandy Braes, discussed fully the exact mode of origin of perlitic cracks and the features which distinguished them from other curved cracks. He points out that the artificial perlitic structure that can be made in a Canada balsam film is a "two-dimensional phase of the natural structure," and from its characters he tries to deduce those of the tri-dimensional phase. His conclusion is that natural perlites are "cracks of more or less irregularly spiralloid character, occurring in the interspaces between sets of polygonal cracks." Allowing for irregularities due to want of homogeneity in the lava, and for the fact that, whereas in the artificial structure the axes of the spirals are all normal to the surface of the film, the axes of the natural spiralloids are variable in direction, he deduces a series of possible figures for sections of true (tri-dimensional) perlitic structure. The most obvious of the characteristics shown by these theoretical sections is that the curves never meet otherwise than tangentially. That these theoretical figures are actually those seen in sections of typical perlitic rocks, affords strong evidence of the correctness of the views suggested as to their mode of formation. Passing on to consider the curved cracks in the quartz crystals (shown by the New South Wales specimen as well as by that described by Mr. Watts), he points out that the cracks, instead of meeting one

another tangentially, do so at marked angles, and are therefore not truly perlitic; while he shows how these also can be imitated artificially. Reasons are given for doubting the perlitic character of cracks in lithoidal rocks claimed as such, and finally the author considers it "extremely improbable that a crystalline aggregate, consisting of individuals with various cleavages and different coefficients of contraction, would be able to develop so delicate a structure" as the true perlitic.

THE *Naturwissenschaftliche Wochenschrift* of November 17 contains a summary of some of the most important preliminary results of forty-seven balloon ascents made in Germany between June 1888 and February 1895, compiled from communications by Dr. R. Assmann in various scientific journals. In four of the ascents the balloons contained self-recording apparatus only, and of the other forty-three cases, M. Berson, an assistant in the Meteorological Office at Berlin, made thirty-six ascents (in four of which he was quite alone), and Lieut. Gross made twenty-eight ascents. The heights attained in some of the voyages were the greatest yet recorded. It was found: (1) That the air-temperature above 4000 metres was considerably lower than had been theoretically assumed, or deduced from earlier ascents. This apparently points to the fact that in the earlier ascents the thermometers were affected by solar radiation, while in the recent ascents this defect was obviated by the use of the aspirator invented by Dr. Assmann. (2) That the assumption that the decrease of temperature with height was most rapid in the lower strata of air, is untenable; the decrease was found to be fairly uniform with increasing altitude, and the isotherm of 32° F. was found to lie between 3600 and 3800 metres. (3) That the stratum between 2000 and 4000 metres was relatively too warm, owing to the greater condensation of clouds in those regions. (4) That the seasonal variation of temperature was very small above the height of 6000 metres. (5) That the inversion of temperature during winter, and at night time, up to the height of 1000 metres, appeared to be a regular phenomenon. (6) That cumulus clouds were at times found at unexpected altitudes. (7) That the surface of a massive layer of cloud affected higher strata of air thermically and electrically, like the surface of the earth. (8) That the electrical potential decreased with height, pointing to the earth as the sole source of atmospheric electricity. (9) That the aqueous vapour was unexpectedly small in even moderately high regions of the air, the variation in amount between two layers of cloud being often very great. The balloon ascents have been temporarily discontinued, with a view to discussing the existing materials.

THE Cryptogamic journal *Grevillea*, which has been published at irregular intervals since Dr. M. C. Cooke resigned the editorship, will not appear again. The papers which were intended for it have been transferred to the *Journal of Botany*, still under the editorship of Mr. James Britten. This journal will be published monthly as heretofore, but will be increased in size from thirty-two to forty-eight pages.

THE Report of the Department of Botany at the British Museum for 1894, by Mr. W. Carruthers, shows that many interesting additions were made to the Herbarium during the year, one of the most important being the collection of fresh-water Algæ made by the late Dr. A. H. Hassall, which includes a number of type specimens. Collections of flowering and flowerless plants have also been obtained, by donation, exchange, or purchase, from all parts of the world, especially from British India and from our other colonies.

MR. F. N. WILLIAMS has issued a provisional and tentative list of the orders and families of British flowering plants, founded on the system of classification of certain continental botanists. He proposes to divide Phanerogamia into three "phyla," Angiospermæ, Anthospermæ, and Gymnospermæ, the second of these consisting of one family only, the Loranthaceæ. The Angiospermæ are again divided into two classes, the Dicotyledones and Monocotyledones; the Dicotyledones consist of two subclasses, the Sympetalæ (Tetracyclicæ and Isocyclicæ) and the Choripetalæ (Eucyclicæ, Phalangiata, Aphanocyclicæ, Calycifloræ, Centrospermæ, and Archichlamydeæ). The whole range of flowering plants is further grouped under 42 orders and 110 families.

APPENDIX II. of the *Bulletin of Miscellaneous Information* of the Royal Gardens, Kew, is devoted to a list of the New Garden Plants of the year 1894. It includes not only plants brought into cultivation for the first time during the year, but also the most noteworthy of those which have been reintroduced after having been lost from cultivation, and some which had not previously been properly described. In addition to species and botanical varieties, all hybrids, whether introduced or of garden origin, but described for the first time in 1894, are included. The number of hybrids is especially noteworthy in *Cypripedium* and other genera of *Orchideæ*. The total number of names in the list is about 500.

AN absolutely black body is one which both radiates and completely absorbs radiations of any wave-length. It is practically impossible to prepare such a body by artificial blackening; but Messrs. W. Wien and O. Lummer have invented a body which answers all requirements in the way of perfect blackness. This quality is impaired by reflection of any kind from the surface, and hence the inventors take care that the body in question shall be supplied with exactly those kinds of radiation which it reflects, and which its radiation lacks in consequence. The interior of a hollow sphere at any uniform temperature is in a perfect condition in this respect, since there is perfect equilibrium between the heat received and given out. By making an opening at one point, this state is only slightly disturbed, and the inside of the hollow sphere will act as a perfectly black body. From a disquisition which appears in *Wiedemann's Annalen*, it appears that the authors propose to use this body and a bolometer to test Boltzmann's law, which makes the radiation proportional to the fourth power of the absolute temperature.

Industries and Iron has commenced the issue of a series of portraits of eminent workers in the field of engineering science. Two portraits have already appeared as supplements to our contemporary—one of Lord Armstrong, in the issue of November 29, and the second, of Sir Douglas Fox, in the issue of December 6.

THE December number of *Science Progress* contains an account, by Dr. D. H. Scott, F.R.S., of the late Prof. Williamson's researches on the carboniferous flora. Other papers included in the number are on mineral transformations, by Mr. H. A. Miers; some applications of the theory of osmotic pressures to physiological problems, by Dr. E. Starling; theories of electrolysis, by Mr. C. Dampier Whetham; recent papers treating of the Upper Palæozoic beds, by Mr. Marr; and a notice of the discoveries and researches of the great physiologist, Carl Ludwig, by Dr. Leon Asher.

SOME of our readers may be interested in an ingenious puzzle which has been devised by Mr. W. Radcliffe. It consists of three sets of discs of equal sizes, each set containing the seven principal colours of the spectrum; and the problem is to arrange nineteen of these so that there will be seven groups of the same size and shape, each group containing the seven different colours. Notwithstanding that there are 5040 possible solutions to this "seven-colour puzzle," the result is by no means easily attained. It should furnish a useful exercise for young children in distinguishing colours.

THE American Ornithologists' Union held its thirteenth annual congress in Washington at the middle of last month. We understand from the New York *Nation*, that a new feature was a special memorial session, at which the late Mr. G. N. Lawrence was eulogised by Mr. D. G. Elliot, and the late Prof. Huxley by Dr. Elliott Coues. The regular scientific sessions were opened by an exhibition of unpublished water-colour paintings by Mr. Louis Agassiz Fuertes, a student of Cornell University, on whom some of the members seemed to think that the mantle of Audubon himself had fallen. Mr. W. T. Blanford was promoted from corresponding to honorary membership, and Mr. W. H. Hudson was admitted to the former. Mr. William Brewster, of Cambridge, succeeded Dr. Coues in the presidency, and the Union meets at Cambridge, Mass., next year.

THE recently-published number of the *Proceedings* of the Liverpool Geological Society (vol. vii. part 3) contains the address on "Chemistry as an Aid to Geology," by Mr. Dickson, the retiring President. He points out, among other things, the value of chemical analyses in tracing the source of drift-deposits, and particularly insists on the importance of discriminating between true *clay* and the *rock-flour* which commonly passes by the same name. Other papers in the same number deal with matters of local geology, including descriptions of new railway cuttings near Seacombe, and a moraine in the Brecknock Beacons. An important discovery of abundant *Lepidostrobi*, exhibiting various stages of development, and in actual connection with the branches of *Lepidodendron*, is recorded from St. Helens by Mr. Lomas, who also contributes an account of the Faroë Islands.

MESSRS. C. W. FAULKNER AND CO. have sent us a number of specimens of their Christmas publications, including Christmas cards, photogravure pictures, calendars, and games. What connection there is between these things and science may not be very clear at first sight. We are so used to calendars that we forget that time was when men had to look to the skies "for signs, and for seasons, and for days and years." This duty is now relegated to astronomical observers and computors, while the average man concerns himself with more mundane affairs. The pictures upon the Christmas cards are not gaudy abominations, but attractive reproductions from photographs of bits of scenery; they should remind people of the gifts of science to art, and, with the photogravure pictures, they show what excellent illustrations can now be obtained by photographic processes. As to the new games received in Messrs. Faulkner's packet, they are ingenious and offer means of pleasant relaxation from mental work.

THE first number of the *Scientific African*, which has come to hand, gives promise of a useful existence, as an exponent of South African science, arts, and crafts. The journal has a large region, full of objects and wonders of transcendent interest, as its sphere of influence. It can do much to stimulate scientific observation, and in its pages one may hope to find valuable information on the animals, minerals, and industries of South Africa. We notice in the number before us an article in support of the geological survey of Cape Colony, showing that the immediate undertaking of the survey is necessary: (*a*) in the interests of pure science, (*b*) in treating the land, (*c*) for the sake of the water supply, (*d*) for the development of the mineral resources. There is also an article on the white-tailed wildebeest or gnu, accompanied by a photograph of a male and female contained in the Selous collection in the South African Museum. Among other contributions are articles on natural gas and petroleum, a biographical notice (with portrait) of Dr. P. D. Hahn, an account of the Brandolei hot spring near the city of Worcester, South Africa; several letters, science notes, a notice of Pasteur, and a brief report of the British Association meeting at Ipswich. We wish the new journal a long and successful life.

THE forty-fifth volume of the *Jahrbuch der k.k. Geologischen Reichsanstalt* opens with a valuable series of analyses made in the laboratory of that institution by C. von John and C. F. Eichleiter. The first group of analyses are of coals of various ages and from various localities in Austria. The rest comprise ores, sedimentary rocks, water, metals, &c. This is followed by a paper on the distribution of the minerals in the lodes of Strebsko near Pribram. Kerner contributes a description of some Cretaceous plants from Lesina, which are of interest owing to the abundance of Cycadeæ. Felix Karrer issues two further instalments of his studies on the Cainozoic deposits of the Vienna basin. Dr. F. E. Suess gives the results of his investigations as to the earthquake which occurred around Neulengbach, near Krems on the Danube, on January 28, 1895. He discusses previous shocks in the same district, and concludes that the transverse axis of this earthquake area follows the strike of the mountains. C. Zahalka discusses the stratigraphical position of the "Bischitzer Uebergangsschichten," which Anton Fric regarded as the lowest member of his Iserschichten group. Zahalka divides the Bohemian chalk into ten zones, and on Fric's view the Bischitzer passage beds would belong to zone No. 8 of this series. The author, however, maintains that it belongs to his zone No. 4, or the Upper Drinowèr Knollen of Fric; that is to say, in English terminology it is transferred from the Senonian to the Lower Turonian. A second important paper on the Bohemian Chalk is contributed by J. J. Jahn, who advances the important conclusion that the Iser Schichten of Eastern Bohemia, are only a local representative of the Teplitzer Schichten, instead of being a distinct formation and of an earlier age.

Bulletin vol. ii., No. 4, of the College of Agriculture, Imperial University, Tokio, Japan, contains much gratifying evidence of scientific activity in the Far East. Dr. Oscar Loew, the professor of agricultural chemistry, continues his paper on "The Energy of the Living Protoplasm," and Mr. G. Daikubara has a second paper on "The Reserve Protein in Plants." Then follow four papers by Mr. Y. Kinoshita, dealing severally with the consumption of asparagine in the nutrition of plants, the assimilation of nitrogen from nitrates and ammonium salts by phænogams, the presence of asparagine in the root of *Nelumbo nucifera*, and the occurrence of two kinds of mannan in the root of *Conophallus konyaku*. Mr. K. Yoshimura has a note on the chemical composition of some mucilages, and makes incidental reference to the facts, of industrial importance, that the mucilage of *Sterculia platanifolia* and of *Kadzura japonica* is used in Japan for sizing paper, and that the tuberous rootstock of *Colocasia antiquorum* serves as a valuable food in Japan, where it is largely cultivated. Mr. M. Inouye deals with the preparation and chemical composition of *tofu*, which consists principally of the protein-matter of the soya bean, is said to be as easily digestible as beef, and can therefore be used to make up the deficiency of proteids in rice, the staple food of man in Japan and China. The same author has a note on *nukamiso*, which is rice-bran in a state of lactic fermentation, and is used to soften certain vegetable foods, such as the radish and the fruit of the egg-plant, which are rendered palatable and easily digestible when left in a large quantity of *nukamiso* for about twenty-four hours. Mr. J. Cho answers in the negative the question, Does hydrogen peroxide occur in plants? Mr. Yoshimura, previously mentioned, has a note on the behaviour of hippuric acid; he concludes that decomposition of hippurates proceeds more quickly in the surface soil than in the subsoil, that it is attended with liberation of ammonia, and that it is chiefly dependent upon the action of micrococci.

THE additions to the Zoological Society's Gardens during the past week include an Arabian Baboon (*Cynocephalus hamadryas*) from Egypt, presented by Mrs. Locke King; two Tufted Umbres (*Scopus umbretta*) from Bechuanaland, South Africa, presented by Mr. F. J. Newton, C.M.G.; four Cockateels (*Calopsitta novæ-hollandiæ*), a Many-coloured Parrakeet (*Psephotus multicolor*), a Rose-Hill Parrakeet (*Platycercus eximius*) from Australia, presented by Mr. Thomas J. Manns; two Red and Blue Macaws (*Ara macao*), five Saffron Finches (*Sycalis flaveola*), two Pileated Song Sparrows (*Zonotrichia pileata*), a Guttural Finch (*Spermophila gutturalis*), a Plumbeous Finch (*Spermophila plumbea*), a White-throated Finch (*Spermophila albogularis*), a —— Finch (*Spermophila torqueola*), a Black-throated Siskin (*Chrysomitris magellanica*) from South America, a Brambling (*Fringilla montifringilla*), a Greenfinch (*Ligurinus chloris*), European, presented by Mr. A. J. Chalmers; a Red-vented Bulbul (*Pycnonotus hæmorrhous*) from India, presented by the Hon. Miss E. Dillon; a Chestnut-breasted Finch (*Donacola castanothorax*) from Queensland, presented by Mr. A. Rowney; a Hardwick's Mastigure (*Uromastix hardwicki*) rom India, presented by Mr. W. Allen; a Black Swan (*Cygnus atratus*) from Australia, deposited; two Black-necked Stilt Plovers (*Himantopus nigricollis*) from South America, a Green-headed Tanager (*Calliste tricolor*) from South-east Brazil, purchased.

OUR ASTRONOMICAL COLUMN.

THE NEW COMETS.—Numerous observations of Perrine's Comet and a few of Comet Brooks are reported in *Ast. Nach.*, No. 3320. The former is generally described as bright, the nucleus being about 7th magnitude, while the tail is pretty broad, and variously estimated at from 10′ to 20′ in length. From observations up to November 25, Dr. E. Lamp finds the date of perihelion passage to be 1895, Dec. 18·3509 Berlin mean time, and the following ephemeris is given:—

	R.A.	Decl.	Bright-ness.
	h. m. s.	° ′ ″	
Dec. 11 ...	15 59 40 ...	−24 7·6 ...	28·30
12 ...	16 16 14 ...	26 2·1	
13 ...	34 33 ...	27 50·5	
14 ...	16 54 40 ...	29 25·0	
15 ...	17 16 5 ...	−30 37·4 ...	60·0

The unit of brightness is that on November 18. The comet is brightening with great rapidity, but it is so near the sun that observations can only be made in daylight.

Comet Brooks apparently presents only the appearance of a feeble, diffused nebulosity without condensation. The following ephemeris for Berlin midnight is due to Dr. H. Kreutz:—

	R.A.	Decl.	Bright-ness.
	h. m. s.	° ′	
Dec. 12 ...	7 16 42 ...	+57 23·5 ...	0·8
13 ...	7 0 37 ...	59 45·8	
14 ...	6 43 39 ...	61 48·0 ...	0·6
15 ...	26 4 ...	63 31·2	
16 ...	6 8 2 ...	64 56 7 ...	0·5
17 ...	5 49 52 ...	66 6·2	
18 ...	31 47 ...	67 1·4 ...	0·4
19 ...	5 14 6 ...	67 43·7	
20 ...	4 57 4 ...	+68 15·0 ...	0·3

The brightness on November 24 is taken as unity. According to the elements adopted, perihelion was passed on October 20·887.

It will be seen that the comet is now circumpolar.

THE GREAT COMET OF 1843.—In the *Astronomische Nachrichten*, No. 3320, Dr. Kreutz gives another chapter in the history of the three interesting comets of 1843 I., 1880 I., and 1882 II., all belonging to one cometary system, distinguished by great brilliancy and small perihelion distance. In 1889, Dr. Kreutz published an exhaustive monograph on the motion of the 1882 comet, that one of the system which, it will be remembered, was first seen in this country by Dr. Common, in bright daylight, and which at the Cape was followed till it seemed to touch the sun's limb. The present inquiry has reference to the 1843 comet, also seen and observed in full daylight, and the motion of which had been made the subject of a classical discussion by Dr. Hubbard (*Astronomical Journal*, vols. i. and ii.). The improved normal places which Dr. Kreutz has formed are not, however, very well represented by Hubbard's orbit, and new elements have been derived, which, of course, do not differ materially from the earlier results. The period, deduced as the most probable, is 512 years, or twenty years less than Hubbard's period; but the interesting point in the present discussion is the determination of several orbits with various values for the semi-axis major, assigned on the hypothesis that this comet of 1843 is identical with some other the appearance of which has been recorded. The periods assigned are thirty-six years, suggested by a possible identity between the 1843 and 1880 comets; 175 years, which would make the 1843 comet a reappearance of that in 1668; 800 years, a period approximately equal to that found for 1882 II., and finally a parabolic orbit. The result is to settle very decisively that there is no identity between the 1843 and 1880 comets, and almost as certainly that the comet is not a return of that of 1668. On the other hand, it is by no means certain that equal periods would not satisfy the observations in both 1843 and 1882, but true parabolic motion cannot be accepted. From the position of the line of intersection of the orbital planes of the two comets 1843 and 1882, Dr. Kreutz infers that they originally formed one comet, and that the separation into two distinct bodies was effected near the time of perihelion passage. Seeing that the 1843 comet would approach within 100,000 miles of the sun's surface, it is easy to suggest a cause for the subdivision.

NEBULOSITIES AROUND THE PLEIADES.—The nebulous relationships of the Pleiades, brought so forcibly into view by the beautiful photographs of Dr. Isaac Roberts, are carried a stage further by a photograph which we owe to Prof. Barnard. This was taken with the 6-inch portrait lens with a total exposure of 10h. 15m. on December 6 and 8, 1893, and an enlargement and description of the plate are given in the current number of *Knowledge*. In this photograph the nebulæ photographed by Dr. Roberts are submerged in the "burnt out" images of the brighter stars; outside the group various nebulous masses and streams are seen extending in all directions, but apparently connected with the nebulosities of the cluster itself. The most prominent of the new nebulosities are two irregular streams flowing from the north and south sides of the cluster, and running three or four degrees easterly; the northern stream is double for a part of its length, but the upper part is very feeble. The nebulosities have also been photographed by Dr. Wilson, of the Goodsell Observatory, with an exposure of 11 hours; they are best seen by increasing the contrast in a positive copy of the plate.

THE FIRST STEPS IN SERUM-THERAPY.

IN scientific discovery, as in many other walks of life, it frequently happens that the magnitude of the result achieved casts into obscurity the labours which led up to that discovery, just as the parent is often forgotten in the fame which may subsequently surround the work of his offspring. It is rarely, however, that so young an infant as we must perforce recognise antitoxic serum to be, succeeds in baffling the pedigree-hunter; barely recognised three or fours years back, its parentage has, however, already become the subject of much discussion.

Dr. Welch, of Baltimore, in an exhaustive paper[1] on the treatment of diphtheria by anti-toxin, commences with an historical survey of the subject, and states that Babès and Lepp in 1889 were the first to publish results of experiments to solve the question whether the fluids and cells of animals which have been rendered immune by vaccination, have not become vaccines and capable of protecting also other organisms. On turning, however, to the volume of the *Annales de l'Institut Pasteur*, in which the memoir by Babès and Lepp[2] on this subject is published, we find that they do not claim to have originated these investigations, for they expressly state: "We have seen, in the course of our investigations, that this problem has been studied experimentally in various diseases, and this fact encouraged us to pursue this idea."

[1] "The Treatment of Diphtheria by Antitoxin," *Trans.* Association of American Physicians, vol. x., 1895.

[2] "Recherches sur la vaccination antirabique," *Annales de l'Institut Pasteur*, vol. iii., 1889.

In the address on Pasteur, delivered before the British Association at Ipswich, Prof. Percy Frankland distinctly attributes this discovery to Héricourt and Richet. He said: "This astounding antitoxic property of the blood-serum of an artificially immunised animal was first discovered by Héricourt and Richet in respect of animals immunised against one of the common abscess-producing organisms."[1]

Now Dr. Welch goes out of his way in a foot-note reference to Babès and Lepp to mention that "Richet and Héricourt are sometimes quoted as the first experimenters to show that the blood of animals is capable of conferring protection upon susceptible animals, but their work *has no reference to modern serum-therapy, as their experiments were made with the blood of dogs which had not previously been vaccinated or treated in any way.*"

If we refer to the *Comptes rendus* for 1888, we shall find a paper by Héricourt and Richet entitled "Sur un microbe pyogène et septique (*Staphylococcus pyosepticus*) et sur la vaccination contre ses effets." In this memoir the authors describe their experiments on procuring immunity in rabbits towards this organism by inoculating them with weakened cultures of it. They conclude by saying: "The methods which we have used to procure these vaccinations are those in general use by Pasteur and his pupils. But we have conceived of a new method (the peritoneal transfusion of a dog's blood into rabbits), a process which also produces vaccination; in a subsequent communication we shall describe in detail the results obtained by this method."

It is this subsequent paper which has been entirely overlooked by Welch and other investigators. Strange to say, also, there is absolutely no reference to it in the *Centralblatt für Bakteriologie*, although a very incomplete abstract of the earlier paper did appear in this journal. This second communication, to which, in the light of recent scientific investigations on the use of antitoxic serum, much interest and importance attaches, is entitled "De la transfusion péritonéale, et de l'immunité qu'elle confère" (*Comptes rendus*, 1888, p. 748).

The following passage, taken from this memoir, will perhaps most clearly convey some idea of what results were obtained by Héricourt and Richet in these first investigations in serum-therapy:—"On October 4, seven rabbits were inoculated with four drops of a culture of the *Staphylococcus pyosepticus*, six having received 48 hours previously some dog's blood in the peritoneum. The control animal[2] died in less than 20 hours after the inoculation. Of the six others, three died, one 50 hours, the other 70 hours, and the third 90 hours after the inoculation. The three others survived; they are still alive at the present time. To explain the apparent inconsistency of these results, it must be noted that the transfused blood was obtained from two different sources: first, from a dog which had never been experimented upon—the rabbits which received this blood did not survive the inoculation; secondly, from a dog which had survived inoculation made some months previously with the *Staphylococcus pyosepticus:* the three rabbits which received this blood survived the subsequent inoculation with the *Staphylococcus pyosepticus.*" These results were confirmed by further investigations, proving, as the authors say, that it was not "un fait exceptionnel." In the course of their experiments Héricourt and Richet found that the blood of untreated dogs did endow rabbits with a certain degree of protection from subsequent inoculation with this micro-organism, inasmuch as the course pursued by the disease in the case of these rabbits was distinctly modified, being less virulent and less rapid, but they expressly state that they consider the assumption justified that the blood of dogs inoculated with this *Staphylococcus*, is capable of conferring immunity of a more complete nature than that obtained by using the blood from untreated dogs.

It is sufficiently apparent, therefore, that these experiments of Héricourt and Richet, far from having "no reference to modern serum-therapy," are the original investigations from which the antitoxic treatment of disease by means of blood-serum has directly followed.

The authors conclude this most interesting memoir by expressing the hope that the injection of the blood of an animal endowed with a natural power of resisting a particular disease may possibly be able to protect other animals, not so fortunately endowed, from attacks of this disease. So far, however, this hope has not been realised. In an article entitled "Recent Studies on Diphtheria" (NATURE, August 22, 1895, p. 393), it was pointed out how the natural or race immunity of one animal to a particular disease was not capable of being transferred, by means of its blood-serum, to another animal susceptible to this disease. We read: "This remarkable circumstance has been once more very clearly demonstrated by Wassermann in the case of diphtheria, to which disease white rats are absolutely immune. In order to test the character of white-rat-serum as regards diphtheria infection, fatal doses of diphtheria toxin were administered to guinea-pigs along with such serum, but in no case did the latter survive, showing that this serum possessed no anti-diphtheritic properties whatever, and was incapable of protecting animals from diphtheria infection."

In connection with the wider application of anti-toxic serum in the treatment of disease, it is interesting to note that already in 1889 Messrs. Babès and Lepp experimented with it successfully in the treatment of rabies, obtaining the anti-toxic serum from a dog rendered artificially immune to hydrophobia. So far, but little advance has been made with it in this direction; since, however, scientific attention has been so attracted to this subject by the success which has attended the use of anti-toxic serum in diphtheria, we may certainly anticipate many fresh developments in its beneficent application.

[1] *Times* Report, September 17, 1895.

[2] Not previously inoculated with dog's blood.

THE MAJOR PREMISS IN PHYSICAL CHEMISTRY.[1]

CHEMISTRY is essentially an inductive science, mathematics is essentially deductive, while physics holds an intermediate position. Yet in our own science, generalisations are reached from time to time, which serve as major premises for syllogistic reasoning. For example, the proposition that each portion of matter has constant weight is at the basis of our knowledge of chemical equivalents as determined by the balance; the isolation of the metals of the alkalis and alkaline earths led to an insight into the nature of salts in general as metallic compounds; and the "periodic law," though not expressed in precise mathematical language, is a most fruitful generalisation of generalisations.

Physical chemistry, following the logical methods already so largely adopted in physics, is characterised by a readiness to use the major premiss. Instead of making a separate experiment to answer each question of fact, the conclusion may often be reached on theoretical grounds, in the same sense as an engineer may demonstrate the stability of the structure he has designed, or the movements of a newly invented machine. What, then, is the leading major premiss in modern chemistry? and what shall be the conditions of fruitfulness?

The doctrine of energy, as based upon thermo-dynamics, embraces the two laws of conservation and correlation; first, energy (while convertible from one form to another) is constant in amount; second, while work may be wholly converted into heat, only a definite fraction of heat can be converted into work. To specify more clearly, if a quantity of heat, H, is received at temperature T (from absolute zero), and if this is converted into work as far as possible by any ideal process until there remains the quantity H′ at temperature T′, then the simple theorem holds that the two quantities of heat are proportional to the two temperatures; and of course the difference between heat received and heat remaining (that is, the work) is proportional to the difference in temperature. Or in algebraic language,

$$H : H' \quad :: T : T'$$
$$H : H-H' :: T : T-T'$$
$$\text{Work}, = H-H' = \frac{T-T'}{T}.H$$

This equation shows what *fraction* of the heat may be converted into work, under the most favourable conditions; namely, the fall in temperature divided by the absolute temperature at which the heat is supplied.

My present purpose is to present this topic in its bare outlines, and with the greatest simplicity possible. Those who wish to follow the deductive reasoning in detail must use the notation of the calculus, in accordance with the following steps. Combining the formula for the total work (as implied in the first law) with that for work derived from change of temperature (the second

[1] Abstract of a paper prepared by request, to introduce the topic of Physical Chemistry, for the American Association for the Advancement of Science. Read September 2, 1895. (Reprinted from *Science.*)

law), we deduce a differential equation for the work obtained or required in isothermal changes. The change under consideration may involve external work, as when a vapour or gas is generated against atmospheric pressure; or it may be internal work of different kinds, as when the molecules are endowed with increased kinetic energy in volatilising, or when a compound is decomposed into its constituents, with increased potential energy.

A somewhat difficult but important paper by J. Willard Gibbs[1] treats of the equilibrium of heterogeneous substances, giving deductions from the two laws of thermo-dynamics, which in turn become major premises for a host of further deductions; so broad, indeed, are the propositions of Gibbs, that the distinctions between chemistry and physics do not appear; there may be two "heterogeneous substances" of like chemical nature, as water and its vapour; there may be three chemical bodies, as limestone with the lime and the carbon dioxide obtained by ignition; or there may be several physical mixtures, as solution of water in ether, solution of ether in water, and the mixed vapour resting upon both liquids. Now, a little consideration will show the importance of knowing when equilibrium is established, for this is equivalent to saying that no further action can take place; the solution is saturated, no longer acting upon the salt; or the gas which has been generated under pressure is no longer evolved. When a change takes place spontaneously, as when I drop a stone, or mix sulphuric acid with water, heat is developed from some other form of energy. To reverse the process, work must be done. The conversion of heat into work is limited by natural law; when a given change implies the doing of work, and that work is forbidden by the terms of our major premise, the change is impossible, equilibrium prevails.

"Osmotic pressure" in dilute solutions is analogous to the pressure of gases; the Gay-Lussac-Marriotte law, with slight modification of terms, applies to molecules in the liquid state. If work is required to diminish the volume of a gas by means of pressure, work is likewise required to diminish the volume of a body in dilute solution, whether the solvent be removed by evaporation or by freezing. Boiling point and freezing point of the solvent are changed by the presence of the dissolved body. The agreement of observed facts with theoretical deductions has led to important methods of determining molecular weights, while the apparent discrepancies in the case of electrolytes have proved an important argument for the doctrine that these compounds are dissociated into their ions.

The mutual indebtedness of technology and pure science has already been pointed out. Manufacturing processes afford many examples of change which are not carried to completion; it is important to know how far the operation can be improved to afford a larger yield, a purer product or less waste. Combustible gases issue from the blast furnaces. There is still a great reducing power in this mixture of carbon monoxide with carbon dioxide. Can it be utilised by enlarging the furnace? Immense furnaces were built in order to secure a larger yield of iron, but the results were disappointing. The law of mass action shows that the equation

$$Fe_2O_3 + 3CO = 2Fe + 3CO_2$$

is limited by certain conditions of equilibrium, and that the ratio of the two oxides of carbon could not be greatly improved over that already secured in practice. The expense of a technological experiment might have been saved, had the indications of mathematical chemistry been heeded.

What hopeless confusion seems to prevail in our present knowledge of solubilities; yet how important in the separations required for chemical analysis. Here, again, we deal with questions of equilibrium. Will work be done at the expense of heat or not?

There are two special difficulties in the general application of thermo-dynamical principles: first, the minor premise is often wanting; and, second, the mathematical form of reasoning is often difficult for the best laboratory workers. Among the published data of thermo-chemistry, some have been determined directly, some indirectly; it is often difficult to find the data desired, or to judge of their accuracy. A critical compilation of all available thermal data, conveniently arranged for reference, with at least some indication of the probable errors, would be very desirable. Many such data might be computed indirectly from experimental determinations of equilibrium. Many empirical equations have been computed, showing solubility as a function of temperature. Who will trace the correlation among such, and thus add a large chapter to thermo-chemistry? What genius shall discover that form of mathematical function that shall substitute rational for empirical equations with a clear interpretation for each constant required? "But this work is mathematical rather than chemical," you will say. Yes, it is applied mathematics; and mathematicans (not being chemists) are not likely to undertake such a task for us, unless we ask their counsel and aid. Specialisation is inevitable; yet by too arbitrary a specialisation, we may inadvertently lose the very help we need. Again would I emphasise the fruitfulness which follows a "cross-fertilisation of the sciences" (*Journ. Amer. Chem. Soc.*, 15, 601 (1893). Judging from the advances recorded in late years, especially in the *Zeitschrift für physikalische Chemie*, it is safe to predict great developments for the rising generation. I heartily echo the sentiment that we need more data; yet great stores of observations upon record have not yet been coordinated and put to use. Ostwald, desiring to know the influence of free iodine upon a reduction process, made three series of determinations (twenty-four in all) from which he concludes that the influence is *not* proportional to the mass. It was no part of his purpose to discover what the law of retardation is; but others might well follow out this clue, using also the data supplied by Meyerhoffer, and supplementing these with further experiments if needed. A glance at the literature of solubilities, and the lack of rational formulæ to express broad generalisations, may convince us that a great mine, with abundant ore "in sight," is awaiting development; or, rather, that ore has been run through a stamp-mill to extract half the gold, while fully half still remains in the tailings, awaiting more perfect methods of treatment.

Much may be learned from the systematic habits of the astronomer, dividing his work among the several observatories in a spirit of helpful co-operation, and assigning the labour of computation to those who are fitted thus to follow the lead of others. What better service can we do for the University student than to set before him some of the problems in mathematical or physical chemistry that require patient toil, and give him the pleasure of assisting in their solution by the use of logarithms and squares? What is more practical than to utilise any service he can render?

In conclusion, I beg leave to suggest the appointment of a joint Committee (representing Sections A, B and C of the American Association) to consider the feasibility of striving towards the following ends:

(1) The compilation of all reliable data of physical chemistry in convenient form for reference, distinguishing those determined directly from those calculated indirectly.

(2) The calculation of empirical formulæ, to combine any series of data, when some better form of generalisation is not already at hand.

(3) The preparation and use of rational formulæ, wherever possible, to deduce the natural constants from series of observations, and to express the conditions that may be expected to hold between observations of different kinds.

(4) The organisation of a band of volunteer compilers and computers from among advanced students, who (with the counsel and aid of their instructors) may assist in the work of compiling data and computing formulæ.

While the time did not seem ripe for the appointment of such Committee at the late meeting of the A. A. A. S., the writer would be pleased to receive any further suggestions from those interested, regarding the points noted above.

ROBT. B. WARDER.

[1] *Trans.* Conn. Acad., 3, 108, 343 (1874-78). See also, *Amer. Jour. Sci.* [3] 16, 441 (1877); 18, 277 (1878).

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—At the 160th meeting of the Junior Scientific Club, held on Wednesday, November 17, the following officers for next Term were elected:—President, E. C. Atkinson; permanent treasurer, D. H. Nagel; treasurer, N. V. Sidgwick; biological secretary, R. Warren; chemical secretary, H. P. Stevens; editor, A. W. Brown; committee, R. A. Baddicom, M. Hesketh, T. J. Garstang. It was announced that Prof. W. Ramsay had consented to deliver the fifth Robert Boyle Lecture in the Summer Term, 1896.

CAMBRIDGE.—The late Mr. James Carter has bequeathed his collection of fossil Crustacea, on which he was a recognised authority, to the Woodwardian Museum. A portrait of the late

T. Sterry Hunt, Hon. LL.D. of the University, has been presented to the same Museum by Mr. Douglas, of New York.

The Walsingham Medal, given annually by the Lord High Steward for an essay on a biological subject, has been awarded to Mr. I. L. Tuckett, Fellow of Trinity College. Essays for the next award are to be sent in to Prof. Newton, by October 10, 1896.

Dr. Joseph Griffiths has been appointed an Examiner in Surgery.

The Special Board for Medicine propose a new scheme for the degree of Master in Surgery, whereby the degree will be open to M.A.s and B.C.s who have made contributions of sufficient merit to the advancement of the science or art of surgery.

Prof. J. G. McKendrick, F.R.S., has been appointed an Elector to the Chair of Physiology, in the place of the late Prof. Huxley.

A grant of £50 has been made by the State Medicine Syndicate to the Department of Pathology, in aid of the course of bacteriology there given.

The Agricultural Science Syndicate report an increase in the number of candidates for the University's diploma in agriculture. All of the candidates at the recent examination were trained in Cambridge, and one of them obtained the silver medal of the Royal Agricultural Society. Seventeen students, all of them members of the University, are now attending the courses provided in the sciences bearing on agriculture. The fees for the examination are not yet sufficient to meet the expenses.

THE Calendar (1894-95) of the Imperial University of Japan, which has come to hand from Tokyo, should be seen by all who desire to know something about the history of that University, and the work that is being done. The number of professorial chairs in the several Colleges appears surprisingly large to those who are not familiar with the character of the University. There are twenty-three chairs attached to the College of Medicine, twenty-one to the College of Engineering, seventeen to the College of Science, and twenty to the College of Agriculture, not to mention those in the Colleges of Law and Literature. From each of the Colleges valuable memoirs on special researches have been issued, and the University seems to be carrying out the objects of its founders, viz., "the teaching of such arts and sciences as are required for the purposes of the State, and the prosecution of original investigations in such arts and sciences."

MR. WILLIAM TATE, of the Royal College of Science, South Kensington, has been appointed Professor of Chemistry at the Civil Engineering College, Sibpur, Calcutta.

PROF. R. A. SAMPSON has been appointed to the chair of Mathematics in Durham University, vacated by the resignation of the Rev. R. J. Pearce.

THE parts of the University of Virginia destroyed by fire are being rebuilt. *Science* states that reconstruction of the Rotunda, the central building of the group recently destroyed, has already been begun. The necessary money to do this, about £16,000, has been practically subscribed. It is proposed to build a general academical building costing £18,000, a physical laboratory costing £6000, a building for mechanics and engineering costing £6000, and a building for the law school costing £4000. Governor O'Ferrall has promised to recommend in his message to the State Legislature a prompt and liberal appropriation to repair the losses of the school, and it is hoped that £40,000 will be received from this source. Appeals are being made to friends of the University and of education to contribute to the rebuilding and enlargement of the University.

The annual meeting of the National Association for the Promotion of Technical and Secondary Education was held on Tuesday, the Duke of Devonshire being in the chair. After the eighth annual report of the Association, presented by Sir Henry Roscoe, had been adopted, the Duke of Devonshire opened a conference of representatives of technical education committees of county and borough Councils. The subjects discussed were evening continuation schools, the award and tenure of scholarships, and trade and technical classes.

SOCIETIES AND ACADEMIES.

LONDON.

Institution of Civil Engineers, December 3.—Sir Benjamin Baker, K.C.M.G., President, in the chair.—The Influence of Carbon on Iron, by Mr. John Oliver Arnold. This paper embodied the results of researches undertaken by the author primarily to determine whether, at high temperatures, the carbon still remained in combination with the iron. A series of eight 3-inch square crucible-steel ingots, ranging in carbon between 0·08 per cent. and 1·47 per cent., the total impurities other than carbon averaging 0·2 per cent., were hammered and rolled to $1\frac{1}{16}$ inch diameter. They were then submitted to chemical, mechanical, microscopical, thermal, and magnetic tests, in three standard physical conditions, namely: normal, or cooled in air; annealed, or very slowly cooled; and hardened, or very rapidly cooled. The differential analyses for carbon confirmed the conclusion arrrived at by the author in a previous research, that the hard plates of Sorby's laminæ consisted of pure crystallised Fe_3C; and under certain conditions contained practically the whole of the carbon present in the steel. The mechanical tests showed that in normal steels the tenacity increased with carbon up to 1·2 per cent., a further addition of carbon causing a diminution in the stress. The ductility of normal steel diminished with the carbon; the elongation with 0·1 per cent. of carbon being 47 per cent., and at 1·5 per cent. 3 per cent. on 2 inches. Under compression the softness of normal steel decreased with the carbon until 0·9 per cent. of that element was present. Annealed steels under compression indicated a maximum hardness at 0·9 per cent., and were distinct softer than the normal metals. Steel with 1·5 per cent. of carbon was softer than iron containing 0·1 per cent. In hardened steels the rigidity of the metals increased enormously as the carbon rose. The microscopical investigation showed that pure iron consisted of cubic and octahedral crystals. The general results of the microscopical examination sustained the theory that the hardness of quenched steel was due not to a hard allotropic modification of iron, but to a definite sub-carbide corresponding to the formula $Fe_{24}C$. The magnetic observations on hardened steels had led the author to the conclusions that (1) the magnetic permeability varied inversely as the carbon present; (2) the permanent magnetism was directly proportional to the carbides of iron present; and (3) in iron containing between 0·1 per cent. and 0·9 per cent. of carbon the permanent magnetism was directly proportional to the sub-carbide of iron present. The author based the existence of a sub-carbide of iron, possessing the formula $Fe_{24}C$, to which the phenomena of hardening and tempering were due, on the following experimental facts: (1) the well-marked saturation points in the micro-structure of normal, annealed, and hardened steels; (2) a sharp maximum in a curve, the co-ordinates of which were heat evolved or absorbed at the carbon change point, Ar. 1, and the carbon percentage; (3) a point in the compression curve of hardened steels at which molecular flow ceased; and (4) a sharp maximum in a curve, the co-ordinates of which were the carbon percentage and permanent magnetism in hardened steels.—The Dilatation, Annealing, and Welding of Iron and Steel, by Mr. Thomas Wrightson. This paper dealt with investigations of some of the physical changes which occurred in iron during its passage from the homogeneous molten state to the solid and more permanent condition. With regard to the alleged floating of solid iron upon molten iron of the same kind, the author had found that if the piece of solid iron was lowered into the liquid metal by means of an iron fork, it always descended with the fork, but in a few seconds left the prongs and floated to the surface. For some time the sphere continued to rise above the surface until, at such a temperature that it melted, it quickly joined the molten metal. On first sinking the ball proved itself to be denser than the liquid iron. It then expanded and became considerably less dense than the liquid; and lastly, a reversal took place and the ball in melting became of the same density as the liquid. The assumption that dilatation was continuous and uniform during the passage from the liquid to the solid state was therefore erroneous. In order to eliminate the errors due to the emergence of the floating body above the surface of the molten metal, the author used for subsequent experiments an instrument by which the specific gravity of a 4-inch cast-iron ball, completely submerged in the metal, could be observed and continuously recorded. A specimen of the record obtained from the apparatus was given. Experiments upon grey Cleveland iron showed that the specific gravities of the cold solid iron, molten iron, and of plastic iron, were 6·95, 6·88, and 6·50 respectively; and that in passing from the solid to the plastic condition, the iron underwent an increase of volume of 6·92 per cent., followed by a quick contraction as it became liquid. The order of experiment was afterwards reversed, and the change of volume was measured as the molten iron solidified. Into two spherical moulds of dried

loam, 15 inches in diameter, was poured in one case Cleveland white-iron, and in the other Cleveland grey-iron. The fluid metal first entirely filled the mould. An expansion of the outer layers then took place as the metal became plastic, the diameter of the ball therefore increasing. The liquid interior, not having commenced to expand, sank in the hollow shell formed by the cooling and expanding layers of the outside, and thus formed a cavity at the top, which was shown in a photograph of the cross-section of the ball. The metal round the inner surface of the top cavity then hardened, and the interior liquid metal expanded gradually towards the centre; and, by its pressure on the soft outer envelope, also tended to increase the diameter of the ball. This action continued until the outer layers arrived at such a temperature that they should contract; when a contest arose between the contracting force of the fast-thickening outer layers and the expanding force of the interior as it in turn became plastic. When these forces balanced each other, further expansion was arrested. After this point in the cooling had been reached, the outer layers contracted as far as their condition would allow, but not to the full natural extent, as, while the outside was in a state of tension owing to the swelling of the interior, fresh layers of plastic and solidifying metal had been built up in the interior. By the time contraction had commenced, these had formed an arch of many courses under different degrees of tension; and such a structure tended to prevent the free contraction of the whole mass. The interior of this enlarged vessel then contracted and drew away principally from the upper part owing to the mass of plastic iron tending to gravitate to the bottom of the ball. The results of further experiments on the buoyancy of solid rolled low-carbon steel showed that it followed the same law as cast-iron. It appeared, therefore, that the physical changes from liquid to solid, as from solid to liquid, were similar in grey-iron, white-iron, and low-carbon steel. In view of the apparent analogy between the expansions of cast-iron in cooling from the liquid to the plastic condition and the expansion of water in cooling from 4° C. to 0° C., the author had undertaken experiments to ascertain whether the welding of iron could be attributed to similar action to that producing regelation in ice. To identify the two phenomena, it must be proved that the surface of the iron at the moment of welding contracted with increase and expanded with decrease of temperature. But as, according to the reasoning of the late Dr. James Thomson, matter possessing this property must also be cooled by impact or pressure, the identification would be complete, if this collateral property of the cooling of welding iron under pressure could be demonstrated. In the author's experiments, which were carried out at the Mint, with the aid of Prof. Roberts-Austen, the temperature at the welding surface of iron heated in an electric-welding machine was taken by a Roberts-Austen recording pyrometer. The results were given of a series of five experiments, in three of which a fall of temperature, ranging between 19° C. and 57° C., had resulted from the application of pressure, at temperatures of between 1300° C. and 1420° C. The thermal expansion of iron was therefore negative between 1300° C. and 1420° C. The theory of regelation in ice was founded on the fact that the melting-point was lowered by pressure. This held good also for iron, in which case, however, there were increasing degrees of mobility between the temperature of 1400° C. and that of melting wrought-iron, 1600° C. When pressure was applied to a bar, *e.g.* at 1400° C., not only was the melting-point lowered, but the mobility of all lower temperatures within the critical condition was increased.

Chemical Society, November 21.—Mr. A. G. Vernon Harcourt, President, in the chair. The following papers were read:—The influence of temperature on refractive power, and on the refraction equivalents of acetylacetone and of ortho- and para-toluidine, by W. H. Perkin, senr. The author ascribes the discrepancies between his own and Brühl's values for the refraction equivalents of acetylacetone, the toluidines, &c., at high temperatures, to experimental error in the use of Brühl's refractometer.—The evolution of carbon monoxide by alkaline pyrogallol solution during absorption of oxygen, by F. Clowes. The author has determined the experimental conditions regulating the evolution of carbon monoxide during the absorption of oxygen by pyrogallol solution, and details the precautions to be taken for the accurate estimation of oxygen by the absorption method.—The composition of the limiting explosive mixtures of various combustible gases with air, by F. Clowes. The compositions of the limiting explosive mixtures of air with methane, hydrogen, carbon monoxide, ethylene, water-gas, and coal-gas are very different; the narrowest limits are observed in the case of methane, the widest in that of hydrogen.—Note on the estimation of butyric acid, by W. H. Willcox.—Some derivatives of anthraquinone, by E. Schunck and L. Marchlewski. The three isomeric methylpurpuroxanthins and several of the ethers of anthraquinoneoxime have been prepared.—Efflorescence of double ferrous aluminium sulphate on bricks exposed to sulphur dioxide, by D. Paterson. The white asbestos-like efflorescence which appears on bricks exposed to sulphur dioxide, has the composition $Al_2(SO_4)_3$, $FeSO_4$, $24H_2O$, and is evidently identical with a salt found in volcanic regions.

Entomological Society, December 4.—Prof. Meldola, F.R.S., President, in the chair.—Mr. S. H. Scudder, of Cambridge, Mass., U.S.A., was elected an Honorary Fellow to fill the vacancy caused by the death of Prof. C. V. Riley.—The Secretary read a copy of a letter of condolence which he had written, by the direction of the Council, to the Entomological Society of France on the death of their President, M. E. L. Ragonot, and he also read the letter in reply from the Secretary of the Entomological Society of France.—Mr. R. Adkin exhibited a specimen of *Mesogona acetosellæ*, taken at Arlington, Sussex, in October 1895. It was stated that this was the first recorded capture of this species in Britain.—Mr. G. T. Porritt exhibited an example of *Halesus guttatipennis*, taken at Lye, Worcestershire, in November 1889. It was believed to be the third British example. Mr. Porritt also exhibited a series of *Mania typica*, showing a curious malformation in all the specimens. He stated that about one-third of a large brood had emerged in exactly the same form, having the wings only half developed, but with the markings clearly defined. Mr. Tutt and Mr. McLachlan referred to similar malformations in *Agrotis tritici* and *Hadena chenopodii*.—Mr. Goss read a communication from Mr. Sidney Crompton, of Salamanca, Tenerife, announcing the capture there by Mr. Hammerton of two specimens of *Diadema misippus*, a species of butterfly not previously recorded from Tenerife. Mr. Crompton said the specimens were in such fine condition that they must have been introduced into Tenerife in the larval or pupal state, and emerged there. Mr. Hampson, Prof. Meldola, and Mr. Osbert Salvin, F.R.S., made some remarks on the distribution of the species.—Mr. Champion read a paper entitled, "On the Heteromerous Coleoptera of St. Vincent, Grenada, and the Grenadines."—Mr. Kenneth J. Morton communicated a paper entitled, "New or Little Known Palæarctic Perlidæ."

Zoological Society, Nov. 19.—Sir W. H. Flower, K.C.B., F.R.S., President, in the chair.—A letter was read from Mr. J. H. Gurney, respecting a kingfisher (*Alcedo beavani*) which had been lately ascertained to be a permanent resident in some parts of Ceylon.—Mr. Sclater gave a short account of the principal animals he had noticed in the Jardin d'Acclimatation and Jardin des Plantes at Paris during a recent visit.—Mr. Sclater exhibited and made remarks upon the skin of a zebra from Nyasaland, obtained by Mr. R. Crawshay, and a remarkably fine pair of horns of a male Livingstone eland (*Oreas canna livingstonei*), which Mr. H. H. Johnston, C.B., had offered for the Society's acceptance. The animal had been shot by one of Mr. Johnston's hunters, in 1893, between Zomba and Lake Chilwa.—Colonel L. H. Irby exhibited and made remarks on two British-killed specimens of the greater bullfinch (*Pyrrhula major*).—Mr. W. T. Blanford, F.R.S., exhibited and made remarks on skins of *Capra sibirica* and of *Ovis ammon*, killed by Major Cumberland in the Altai mountains.—A communication was read from Mr. Swale Vincent, containing contributions to the comparative anatomy and histology of the supra-renal capsules. In the present paper Mr. Vincent described the naked-eye and microscopical anatomy of the supra-renal bodies in the different orders of fishes. He was inclined to the view that supra-renal bodies are present in all the Elasmobranchii, Holocephali, Ganoidei, and Teleostii, and probably also in the Dipnoi. The supra-renal bodies of fishes were in their essence "secreting glands," as the mammalian organ was now supposed to be. There was no relation whatever, in Mr. Vincent's opinion, between the supra-renals and the lymphatic head-kidney. In the great majority, at any rate, of Teleosteans they were both present in a well-developed condition.—Mr. Gerard W. Butler read a paper on the complete or partial suppression of the right lung in the Amphisbænidæ, and of the left lung in snakes and snake-like lizards and Amphibians. The author gave particulars as to the relative development of the right and left lungs in a large number of Amphisbænidæ and other snake-like lizards and snakes and limbless Amphibians,

which appeared to constitute a representative series, and found that, so far as the species on his lists were concerned, it was an invariable rule that in the Amphisbænidæ the right lung was the smaller, and usually rudimentary or absent, while in all other cases of inequality it was the left lung which was the smaller.—Mr. W. Saville Kent read some observations on the frilled lizard (*Chlamydosaurus kingi*) of Western Australia. After describing the peculiarities of this reptile, Mr. Saville Kent stated that he was inclined to regard it, if not as a surviving representative of the Dinosaurian reptilia, as, at any rate, a most interesting and anomalous lacertilian type that inherited its characteristic bipedal method of progression from that extinct group. Mr. Saville Kent's paper was copiously illustrated by photographs taken by him from life of *Chlamydosaurus* in its bipedal running and other characteristic attitudes, and also by specimens which had been mounted in strict accordance with these photographs.—Two communications were read from Dr. A. G. Butler, on a small collection of butterflies made by Consul Alfred Sharpe at Zomba, British Central Africa, and on a collection of Lepidoptera recently collected in Eastern Central Africa by Mr. G. F. Scott Elliot.—A communication was read from Mr. G. S. West, on the buccal glands and teeth of certain poisonous snakes. The author showed that in the Opisthoglyphous snakes the poison-gland is very variable both in form and extent, and that its duct opens into a cavity formed by muscular folds surrounding the grooved tooth. This opening is always towards the outer side of the grooved tooth, and situated either at its base or but a short distance from it, and the parts were shown to be so related that the loss of the tooth does not cause any injury to the duct. The reserve teeth were shown to be in no way connected with the duct until called upon to replace teeth that had been lost. The epithelium of the distal portion of the duct was shown to be of a secretory nature, the cells being mucus-secreting, similar to those forming the lining epithelium of the mouth. In the *Hydrophiinæ* the poison-gland was shown to be more or less free from the superior labial, and to consist of a large number of longitudinally-disposed tubules converging anteriorly towards a central poison-duct. There were two large poison-fangs situated almost side by side at the anterior extremity of the maxilla. The duct when approaching the region of the teeth became slightly sinuous and suddenly enlarged, enclosing a cavity into which there projected two muscular cushions, one in front of the base of each tooth, and it was through the vertical slit between these that the poisonous secretion passed from the duct to the grooves of the poison-teeth.—A communication was read from Mr. William H. Ashmead, containing a report upon the parasitic Hymenoptera of the Island of Grenada, comprising the families Cynipidæ, Ichneumonidæ, Braconidæ, and Proctotrypidæ. This paper enumerated as occurring in Grenada 183 species of the families named in the title, and described 128 of them as new. Of those previously known the majority had been recently described by Mr. Ashmead as found in the neighbouring island of St. Vincent. The Cynipidæ were all parasitic forms, there being apparently a total lack of any gall-making forms of the family in the island.

Geological Society, November 20.—Dr. Henry Woodward, F.R.S., President, in the chair.—The following communications were read:—"Additional Notes on the Tarns of Lakeland," by J. E. Marr, F.R.S. This paper was supplementary to one by the author published in the *Q. J. G. S.*, vol. li. (1895). It contained additional notes on Wateredbath Tarn, described Hard Tarn on Helvellyn, a pond of which the outlet had gradually been diverted from a course over screes to one over solid rock; Hayeswater, a lakelet referred to by Dr. H. R. Mill as in some respects intermediate between the mountain-tarns and the valley-lakes; and Angle Tarn, Patterdale, a good example of a plateau-tarn. In the discussion that followed, Dr. H. R. Mill said that as Mr. Marr had found every tarn that he examined to be held in by a barrier of drift, it seemed most likely that most, if not all, of the larger lakes would be found to owe their origin to the same cause. In this connection it was worth mentioning that Prof. W. M. Davis, of Harvard, considered, from the configuration of the larger lake-basins in the district, that they were produced in drift-blocked valleys.—"Notes on the Glacial Geology of Arctic Europe and its Islands. Part i. Kolguev Island," by Colonel H. W. Feilden, with a report on the erratic boulders from the Kolguev beds, by Prof. T. G. Bonney, F.R.S. Kolguev Island, about the size of Norfolk, was about 50 miles from Arctic Russia and about 130 miles south-west of the nearest part of Novaya Zemlya, with soundings not exceeding 30 fathoms between it and Russia, and probably not more than 75 fathoms between it and Novaya Zemlya. It was entirely composed of a vast accumulation of glacio-marine beds. The northern two-thirds of the island consisted of an elevated ridged area with a maximum height of 250 feet. The author had been furnished with notes by Mr. Trevor-Battye concerning the geology of this region. It was inferred from his observations that this elevated region was composed of beds of sand with erratic boulders not less than 80 feet deep, resting on clays—the "Kolguev clays." Mount Bolvana rose as a symmetrical cone above the tundra, detached from the northern plateau, pointing, in the opinion of the author, to the occurrence of marine erosion. The southern portion of the island was tundra, a dead flat of grass, bog, and peat-levels reaching to the sea; good sections of the Kolguev clays were exposed in the gullies traversing it near the sea on the western coast. In the vicinity of the Gobista river the Kolguev beds consisted of clays merging here and there into sands. They were charged with boulders often ice-scratched, indicating continuous deposition in a comparatively deep sea. The beds yielded many shells of arctic mollusca, such as *Saxicava arctica*, *Mya*, &c., apparently dispersed from top to bottom. The ice-pack had forced many fragments of semi-fossil wood on to the shore, no doubt worked up from a bed immediately below sea-level. No deposit was met with in Kolguev Island precisely similar to what is called "till" in Scotland, though there were many boulder clays in Britain which were in no measure superior in toughness to those of Kolguev; for instance, those of the Yorkshire coast, and the chalky boulder clays of Norfolk. It is suggestive that all the glacial deposits met with by the author in arctic and polar lands (except the terminal moraines now forming above sea-level) should be glacio-marine beds. Prof. Bonney, in his report, described the rocks brought home by the author. A discussion followed, in which Mr. Marr, Mr. Trevor-Battye, Mr. Boulger, Dr. G. J. Hinde, Dr. Gregory, and the Rev. Edwin Hill took part.

CAMBRIDGE.

Philosophical Society, November 11.—Prof. J. J. Thomson, President, in the chair.—The following communications were made:—A method of measuring the hysteresis of iron, by Mr. G. F. C. Searle. A bar of iron is placed in a solenoid, and the magnetising current flowing in the solenoid also passes through the fixed coils of an electrodynamometer. This current can be reversed. A secondary coil is wound on the iron, and the current induced in it by the variation in the magnetic induction passes also round the suspended coil of the electrodynamometer. Thus if H is the magnetic force due to the solenoid, and B is the magnetic induction in the iron, the current in the fixed coils is proportional to H, and the current in the suspended coil is proportional to dB/dt, provided that B changes so slowly that the effects due to self-induction in the secondary circuit are negligible. The couple experienced by the suspended coil at any time is proportional to HdB/dt, and thus the angular momentum acquired during a double reversal of the magnetising current is proportional to $\int HdB$ or to $4\pi\int HdI$, where I is the intensity of magnetisation. Thus the "throw" of the spot of light reflected from a mirror attached to the suspended coil is proportional to the energy lost in hysteresis during the double reversal. Experiments were shown to illustrate the manner in which the method could be applied to investigate the effects of strain and temperature upon the hysteresis in iron.—The form of cubic surfaces containing twenty-seven real straight lines, by Mr. W. H. Blythe. The paper was illustrated by two plaster models. The first represented the general case of a cubic surface having twenty-seven real straight lines, the position of the lines being shown by threads. The second was a rough model of the special form having a tangent plane at infinity, which contains three of the lines. It is constructed to show the position of the remaining twenty-four straight lines, which form a symmetrical system.—Expansion produced by the electric discharge, by Miss Martin. At the suggestion of Prof. Thomson, the experiments of Meissner on the expansion of gases by the electric discharge were repeated by Miss Martin. After some preliminary experiments, in which the results obtained differed from those of Meissner, new apparatus was set up, an exact copy of Meissner's, consisting of an ozone generator with a sulphuric acid pressure-gauge attached; the two tinfoil coats of the generator were connected with the terminals of an electrical machine. In Meissner's original experiments it was

thought that the precaution of never separating the terminals of the electrical machine further than by a small fraction of the distance between the coats of the generator would ensure the absence of discharge between the coats; and in the conditions adopted, Meissner observed that when discharge took place by the passage of a spark between the terminals, there was a temporary increase of pressure; the effect being most marked in the case of CO_2, and least marked in H. In Miss Martin's repetition of the experiments, the generator was put in a dark box, provision being made to let the gauge and the space between the coats of the generator be seen. It was then established that in no case could any deflection of the gauge be seen, except when luminosity could be detected in the generator. It was further observed that when the discharge passed through CO_2 a permanent contraction was produced. The experiments have been repeated by Prof. Thomson, and he finds that if wet CO_2 is used, the effect is more marked; but if carefully dried CO_2 is used, no contraction is produced.

PARIS.

Academy of Sciences, December 2.—M. A. Cornu in the chair.—On the extension of the ideas of Galois to the theory of differential equations, by M. Émile Picard.—Remark on a memoir, by M. Jaumann, entitled, "Longitudinal Light." A note by M. H. Poincaré. The author derives equations, from those found by M. Jaumann, which indicate properties for cathode rays not agreeing with facts, and hence considers that modifications are needed in the hypotheses put forward in the memoir.—On the presence of sodium in aluminium prepared by electrolysis, by M. Henri Moissan. It is shown that electrolytic aluminium contains in general from 0·1 to 0·3 per cent. of sodium, and that the presence of this impurity renders the metal easily attacked by water. Aluminium should always be used alone and pure, as it readily forms electric couples with every other metal, and is then easily attacked by water.—On the origin of argon and of helium in gases disengaged by certain sulphurous waters, by MM. L. Troost and L. Ouvrard. It is shown that, though argon is generally present in waters, helium is only found in certain mineral waters, and does not probably owe its origin to the atmosphere, but to the rocks through which the waters have percolated. M. Bouchard added some remarks on the therapeutic value of helium and argon, and supported the view that these gases have no action on the economy, but admitted that the metals present in helium containing minerals might have medical action when present in minimal amounts.—Structure of the mesenteric ganglia of the pig, by M. L. Ranvier.—Observations on Perrine's comet (16 November, 1895) made with the great equatorial at Bordeaux Observatory by MM. G. Rayet and L. Picart. Note by M. G. Rayet.—M. Ch. V. Zenger, in a note entitled "Studies in molecular physics," sets forth a very simple relation between the density and specific heat of chemical elements, and indicates a new view of the genesis of the elements.—Observations of Swift's comet (1895, August 20) made with the great telescope, and of Perrine's comet (1895, November 16) made with the 0·25m. equatorial at Toulouse Observatory, by M. Rossard.—Note on the construction of the calendar, by M. A. Auric.—On Lamé's equation, by M. G. Floquet.—On the extension of Cauchy's method to systems of equations to the derived partials of any order whatever, by M. J. Beudon.—On the functions of two real variables and on the motion of an arbitrary function, by M. Émile Borel.—On orthogonal systems, by M. Paul Adam.—On a new determination of the ratio between the electrostatic and electromagnetic units, by M. D. Hurmuzescu. The value found gives

$$v = 3{\cdot}0005 \times 10^{10} \text{ to } 3{\cdot}0020 \times 10^{10}.$$

—Relation between the intensity of light and the chemical decomposition which it produces; experiments with mixtures of ferric chloride and oxalic acid, by M. Georges Lemoine. The chemical decomposition of a mixture of ferric chloride and oxalic acid is proportional to the luminous intensity.—On the presence of argon and helium in a natural source of nitrogen, by M. Ch. Moureu.—Experimental determination of the agglutinating power of oils, by M. Louis Campredon.—On a chromium amalgam and some properties of metallic chromium, by M. J. Férée.—On a method of synthesis of complex amides, by M. Albert Colson.—New examples of the superposition of optical effects of asymmetric carbon atoms, by MM. Ph. A. Guye and Ch. Goudet.—On a zoological exploration of Corsica, by M. Louis Roule.—On the anatomy and systematic position of compound Ascidians of the genus *Sigillina*, Sav., by M. Maurice Caullery.—On the accumulation of sugar in beetroots, by M. L. Maquenne.—The pliocene and quaternary glaciers of Auvergne, by M. Marcellin Boule.—On the geology and "tectonique" of the Central Caucasus, by M. E. Fournier.—On two new forms of quartz, by M. P. Termier.—On the effects of the tropical revolutions of the sun and of the moon on the barometric pressure, by M. P. Garrigou-Lagrange.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Congrès de l'Atmosphère 1894, Compte Rendu (Anvers).—Introduction to the Study of Fungi: Dr. M. C. Cooke (Black).—Mensuration for the Use of Schools, &c.: Rev. A. D. Clarke (Rivington).—Modern Microscopy: M. I. Cross and M. J. Cole, 2nd edition (Baillière).—Practical Inorganic Chemistry: Dr. G. S. Turpin (Macmillan).—The Pterophorina of Britain: J. W. Tutt (Hartlepool, Robson).—Elementary Algebra: J. W. Welsford and C. H. P. Mayo (Longmans).—University College, Nottingham, Calendar 1895-96 (Nottingham, Sands).—Compensacion de Declinaciones Magnéticas en la Peninsula Ibérica: Don R. P. de Figueroa (Madrid).—Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbethiere, Dr. O. Hertwig, Fünfte Auflage (Jena, Fischer).—Principles of Metallurgy: A. H. Hiorns (Macmillan).—Macmillan's Geography Readers, Book vii. (Macmillan).—Elements of Geometry: G. C. Edwards (Macmillan).—Essays in Taxation: Prof. E. R. A. Seligman (Macmillan).—Regeneration, a Reply to Max Nordau (Constable).—The Key of the Pacific, the Nicaragua Canal: A. R. Colquhoun (Constable).—Service Chemistry: Prof. V. B. Lewes, 2nd edition (Whittingham).—Physical Measurements: F. C. Weedon (Gill).—Imperial University of Japan, Calendar 1894-95 (Tōkyō).—Handbuch der Mineralchemie: Dr. C. F. Rammelsberg, Zweites Ergänzungsheft zur Zweiten Auflage (Leipzig, Engelmann).—Kurzes Handbuch der Kohlenhydrate: Dr. B. Tollens, Zweiter Band (Berlin, Trewendt).

PAMPHLETS.—Ethnography of the Mullet, Inishkea Islands and Portacloy, Co. Mayo: Dr. C. R. Browne (Dublin).—On Memory and the Specific Energies of the Nervous System: Prof. E. Hering (Open Court Publishing Company).—Spiritual Truth and Common Sense: B. Hodgson (Birmingham, Cornish).—On the Localisation of the Foramina at the Base of the Skull: Prof. E. Fawcett (Bristol, Arrowsmith).

SERIALS.—Botanische Jahrbücher, &c., Zweiundzwanzigster Band 1, Heft (Leipzig, Engelmann).—Zeitschrift für Physkalische Chemie, xviii. Band, 3 Heft (Leipzig, Engelmann).—History of Mankind: F. Ratzel, Part 3 (Macmillan).—Geological Magazine, December (Dulau).—Science for All, cheap edition, Part 1 (Cassell).—Geographical Journal, December (Stanford).—Bulletin de l'Académie Royale des Sciences, &c., de Belgique, Nos. 9 and 10 (Bruxelles).—Bulletin of the American Mathematical Society, November (New York, Macmillan).—Observatory, December (Taylor and Francis).—Companion to ditto, No. 235 (Taylor and Francis).—Strand Magazine, December (Newnes).—Live Stock Journal Almanac, 1896 (Vinton).—Science Progress, December (Scientific Press, Ltd.).

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